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Cunninghamia

A journal of plant ecology for eastern Australia

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Allan Cunningham, botanist and explorer (1791–1839)

Cover: Front cover: Warrumbungle trachyte outcrop heathland (VCA ID391) on Bluff Mountain in Warrumbungle National Park with background views of woodlands dominated by *Eucalyptus dealbata* (Tumbledown Gum), *Callitris endlicheri* (Black Cypress Pine), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus albens* (White Box) and patches of wattle shrublands with *Acacia cheelii* and *Acacia doratoxylon*. A sample of the plant communities of the NSW North West Slopes and west New England regions. Photo Jaime Plaza.

Back cover: Panorama of the Pilliga Scrub forests dominated by trees of *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus fibrosa* (Broad-leaved Ironbark), *Corymbia trachyphloia* (White Bloodwood), *Eucalyptus chloroclada* (Dirty Gum) and *Callitris glaucophylla* (White Cypress Pine), on Jurassic sandstone. Photo Jaime Plaza.

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SHORT COMMUNICATION

Defining indigenous plants: some problematic species from Norfolk Island

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Abstract: Defining indigenous species may at first appear straight forward; most botanical texts provide similar definitions. The consistent requirement of such definitions is the lack of human intervention in the occurrence of the species within the area under consideration. Islands around the world have been invaded by plant species brought to their shores by humans. They are also places where self-introduced species can be continually arriving, as they have done for millennia.

Scrutiny of the situation on Norfolk Island (1200 km east of Australia) finds that the distinction between indigenous and introduced taxa is sometimes unclear. There is also inconsistency regarding the acceptance of self-introduced species as indigenous. This paper explores these issues and notes that they are more important than idle botanical curiosity, because control of introduced (weed) species is a major area of activity in managing protected natural areas.

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Introduction

The concept of the indigenous or native plant taxon, as opposed to one that is introduced (and commonly referred to as a weed), is in some situations not as easy to identify as may at first appear. Definitions of each term are easily constructed, but for some species in some situations the delineation becomes problematic. This problem is apparent on Norfolk Island (1200 km east of Australia), where complications over the status of some species arise because of factors including ambiguous early records and recent discoveries of species that may or may not have arrived unaided. For convenience, Norfolk Island (lat 29° 02'S; long 167° 57'E) refers here to the Norfolk Island Group as a whole.

Introduced taxa are often defined as those that are not native or indigenous (e.g. Harden 2002; Green 1994; Richardson et al. 2006). Although seldom stated, the definition implies non-intervention by humans. While it can generally be established, through a range of investigations, whether a plant species was present before Europeans arrived on Norfolk Island, there are cases, as we shall see, where the indigenousness of a species is anything but obvious. The presence of Polynesian people hundreds of years before Europeans arrived further complicates the situation.

The examples presented here for Norfolk Island demonstrate the problem of defining indigenousness when faced with a range of information that is sometimes ambiguous, fragmentary or open to misinterpretation. The problem is not confined to Norfolk Island or to islands generally. An ambiguous species can have significant implications for the management of protected natural areas, where the goal is usually to remove introduced species.

The Flora of Norfolk Island

The earliest references to plants on Norfolk Island were by James Cook and accompanying botanists, father and son, Johann and George Forster, in the *Resolution* at the time of its European discovery in October 1774. Philip Gidley King, first commandant on the island from 1788, referred to several of the plants found on the island, most particularly to species of known or potential usefulness to the settlement. The earliest attempt to catalogue the plants was an annotated list of 48 species prepared by William Paterson, in charge of the military detachment on Norfolk Island from November

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1791 to March 1793. Paterson's notes accompany a set of 50 corresponding numbered watercolour drawings attributed to his convict servant John Doody.

Ferdinand Bauer visited Norfolk Island in 1804/05 and made extensive collections of plants and drawings. Botanist Allan Cunningham visited in 1830, making an extensive list of the plants he observed on the island; he created names for some of the endemic species but these names were never formally published by him or anyone else. The first *Flora* of Norfolk Island, based on the work of Bauer, was prepared by Stephano Endlicher (1833), who formally described most of the endemic species. The next comprehensive treatment of the flora was not until early in the 20th century (Maiden 1904; Laing 1914). Green (1994) prepared the modern *Flora* as part of the *Flora of Australia* series. Since then, several papers have dealt with various aspects of the island's flora (e.g. Braggins 1996; Lange et al. 2005; Mills 2007, 2010).

The flora of Norfolk Island (latitude 29° 02' south) is subtropical in character and, not surprisingly, exhibits affinities with the closest landmasses, particularly those to the west; 51 percent of the species is shared with Australia, 33 percent with New Zealand, 21 percent with New Caledonia and 6 percent with Fiji (Mills 2007). About 39 percent is shared with Lord Howe Island, the closest land to the west (about 900 km away). The high percentages for Australia and Lord Howe Island can be explained by the fact that the weather systems approach from the west, so that the likelihood of transport of plant propagules is highest from that direction.

The Norfolk Island flora consists of a coastal flora, ubiquitous in the southwestern Pacific region and elsewhere, and a rainforest flora derived from the above landmasses. Endemic taxa represent 24 percent of the indigenous flora. Most of Norfolk Island has been cleared of its original rainforest vegetation since convict times; i.e. pre-1850. The majority of the remaining indigenous vegetation is contained within Norfolk Island National Park and Botanic Garden, managed by Parks Australia, an Australian Commonwealth Government authority (Director of National Parks 2008). These reserves cover 18 percent of the land area of the island group.

Species Indigenous or Introduced

A suite of plant species on Norfolk Island cannot readily be categorised as indigenous or introduced. The examples discussed below demonstrate the problems of defining indigenousness on Norfolk Island.

Historical ambiguity

The rampant creeper *Ipomoea cairica* (Convolvulaceae) is ubiquitous across the western Pacific and a common coastal plant in eastern Australia. Generally considered to be introduced to Norfolk Island, it is usually treated as an invasive weed (e.g. Director of National Parks 2008) and vigorously destroyed on the island whenever possible (K. Mills, pers. obs.). The plant appears on a set of Norfolk Island postage stamps depicting the important weeds of the island. However, Lange et al. (2005) suggested that the species may in fact be indigenous, citing the very early drawing by the convict artist John Doody from about 1792; i.e. four years after settlement. However, *Ipomoea cairica* is one of three species in that genus illustrated among the set of 50 drawings of Norfolk Island plants; the other two being *Ipomoea alba* (as *Ipomoea* sp.) and *Ipomoea indica* (as *Ipomoea congesta*). These two species are definitely introduced to Norfolk Island as they are of tropical origin (Harden 1992; Green 1994). Thus, the early drawing of *Ipomoea cairica* cannot be accepted as conclusive evidence of an indigenous status.

Beach plants were some of the first plants recorded for Norfolk Island by Europeans. James Cook and his party landed on the shore of Duncombe Bay on the north-eastern side of the island in 1774 (Beaglehole 1969). Cook wrote, 'on the isle is fresh water and abundance of Cabbage Palms, Wood Sorrill, Sow-Thistle and Samphire, with which the Shores in some places abound. We brought on board as much of each sort as the time we had to gather them would admit.'

The identity of Cook's 'Sow-Thistle' is problematic. Sow Thistle is the name given to species of *Sonchus* in Britain. In non-botanical texts, the identity of the plant is usually said to be *Sonchus oleraceus* (e.g. Beaglehole 1969; Nobbs 1988). This is unlikely, as that species was not introduced to Australia or anywhere else nearby until settlement in 1788. Lange et al. (2005) suggested either *Sonchus kirkii* or *Actites megalocarpus*, the former found in New Zealand and surrounding islands where it is apparently declining in abundance, the latter species is native to Australia where it grows on sand dunes and beaches along most of the coastline; it also occurs on Lord Howe Island where its indigenous status has been questioned (Green 1994). For the identity of the plant mentioned by Cook, we perhaps need go no further than a species in the same family (Asteraceae) that is still common at Cook's landing place on Norfolk Island today, namely *Senecio australis*. The small, yellow, daisy-like flowers of this species could have looked like a Sow-thistle to Cook and his shipmates as they had no other name to give it. The botanists accompanying Cook, Johann and George Forster, offer no clue as to the identity of the species, George Forster recording only that 'on the beach we found several succulent plants, such as a species of tetragonia [*Tetragonia tetragonioides*], and a mesembryanthemum [*Carpobrotus glaucescens*] ...' (Forster 2000).

Recent arrivals

Several recent arrivals of plant species on Norfolk Island are worthy of consideration in this discussion. The mistletoe *Ileostylus micranthus* (Loranthaceae) arrived apparently unaided from New Zealand in the 1930s. It is regarded as indigenous and even though it preferentially parasitises the endangered endemic small tree *Coprosma pilosa* (Rubiaceae), it is not controlled. In fact, the mistletoe is itself listed as vulnerable under Australian Commonwealth legislation.

Ferns have been arriving on Norfolk Island since the island emerged from the ocean some three to two million years ago. A recent arrival, *Dicranopteris linearis* (Gleicheniaceae), has established a small colony on a road-cutting above Ball Bay. It was not recorded by Green (1994), being first recognised in 1995 (Braggins 1996). Its occurrence is seen as 'natural', having apparently arrived without human assistance. This species occurs widely in the Pacific region and is regarded as indigenous to Norfolk Island (e.g. Lange et al. 2005), but is not listed as threatened.

The tree *Delarbrea paradoxa* (Araliaceae), a native of New Caledonia, New Guinea and other tropical islands, is treated as introduced by Green (1994). Sometime prior to the time the plant was first noticed, a group of Red-crowned Parakeets *Cyanoramphus saisseti* from New Caledonia was reported on Norfolk Island; it is thought that the birds brought seeds of this species to the island (O. Evans, pers. comm.). Other potential seed carriers such as the Long-tailed Cuckoo, *Eudynamys taitensis,* visit Norfolk Island on their migration between New Zealand and New Caledonia,. Lowry (1986) suggested this tree 'is probably the best adapted member of the genus for long-distance dispersal to and establishment in new areas' and further that 'this taxon has fleshy purplish black fruits that appear to be well adapted for bird dispersal'. *Delarbrea paradoxa* evolved in New Caledonia and has spread as far as Timor, almost 5,000 km to the west (Lowry 1986); the distance south to Norfolk Island is only 800 km. This tree is very unlikely to have been brought to the island by humans.

On Norfolk Island, *Delarbrea paradoxa* grows in rainforest and thickets of African Olive, *Olea europaea* subsp. *cuspidata* (Oleaceae), in the western parts of the national park. Various species of fleshy-fruited rainforest trees have been brought to the island over millennia by visiting birds; indeed many are still growing there. Paradoxically given the approach described above to *Ileostylus micranthus* and *Dicranopteris linearis, Delarbrea paradoxa* is currently regarded as an invasive weed and is removed when encountered in the national park (C. Rowston, Park Manager, pers. comm., July 2010).

The short-lived rainforest tree *Homalanthus populifolius* (Euphorbiaceae) is occasionally encountered in rainforest gullies on Norfolk Island. To a botanist from eastern Australia, where the species is common in a similar type of rainforest, this species does not look out of place on the island. The species is indigenous to Lord Howe Island (Green 1994), and was accepted as indigenous on Norfolk Island by Green (1994) but more recently has been considered introduced (Lange et al. 2005), because of the comment by Maiden (1904) that the species 'had come as a seedling with some plants from Lord Howe Island.' Maiden wisely observes, 'it is interesting to trace the history of a plant like this, as a botanist might be excused for recording it without question as indigenous to Norfolk Island.'

Verification through pollen studies

The wetland plant *Typha orientalis* (Typhaceae) is common in eastern Australia, where it is regarded as a weedy invader of drains and artificial ponds, even though it is indigenous. The species also occurs in eastern Asia and some tropical islands, and is indigenous to New Zealand and the Kermadec Islands. On Norfolk Island, Green (1994) treated the species as native, but commented that it was 'possibly an early introduction'. The indigenous status of the species was proven beyond doubt by Macphail et al. (2001) through pollen from a core taken in Kingston Swamp, showing the species was present over 2000 years ago.

Pre-European introduction

The flax *Phormium tenax* (Hemerocallidaceae) of the island has always been considered to be indigenous (e.g. Green 1994). Recently, questions have been raised as to its indigenous status (Macphail et al. 2001; Coyne 2009a). Although present in 1774, the year of European discovery of the island, there is conjecture that Polynesians introduced the species to Norfolk some hundreds of years earlier. Mills (2009) found that there was no firm evidence of Polynesian introduction, although he did not completely discount the possibility. The author particularly questioned the validity of the interpretation of the pollen analysis by Macphail et al. (2001) that purported to show that *Phormium tenax* was not on the island prior to Polynesian arrival because of an absence of flax pollen. When Philip Gidley King arrived to settle Norfolk Island in March 1788, he found bananas growing on the island, confirming that Polynesians had been there. More recently, archaeological investigations below the sand dunes at Emily Bay have shown that Polynesians established at least a small temporary settlement on Norfolk Island. Reported differences in the physical features of the Norfolk Island plants compared to New Zealand plants (M. Christian, Norfolk Island, pers. comm.) and the habitat in which they grow do seem to support an indigenous status. In all likelihood, *Phormium tenax* is indigenous to Norfolk Island, as there is no real evidence that it was brought there by Polynesians. This author is not convinced that this species should be treated as a weed and its use in vegetation rehabilitation ceased, as suggested by Coyne (2009b).

Grasses – the most problematic of all

The grasses pose a particularly difficult group to deal with for several reasons; they were never very common on the island, they do not appear to have been well-documented in the early years of settlement, and even experienced botanists often overlook them. This is evident in the list of grasses prepared by Cunningham in 1830, who spent four months on the island but did not record several species of grass known to be present, although this may be explained because he was on the island in winter.

Many grasses produce structures attached to their seeds that are sticky or have hooks or hairs that are readily transported by birds. Eastern Australian grasses that reached Norfolk Island by means of avian vectors would have found suitable habitat on sea-cliffs and dry ridges free of dense rainforest. Just as easily, the first European settlers to Norfolk could have inadvertently transported those same species from Sydney. Early observations and collections by the first botanists give the impression that the island was almost without grasses. Philip Gidley King wrote, 'not a single blade of grass has been seen on the island' (Fidlon & Ryan 1980). Endlicher (1833), based on Bauer's collections and drawings from 1804–1805, described eight species of grass for the island; three of these are now considered to be introduced.

The number of grass species recognised on the island climbed as successive botanists visited or investigated the flora. The number of species considered indigenous grew from eight in 1833 to 13 in 1994 and presently stands at 15 species. At the same time, identified introduced taxa grew from none to 55. Over that period, acceptance of species as indigenous and introduced swayed backwards and forwards; today there is no universal consensus about several species. A few examples will serve to illustrate the dilemma. The species *Cymbopogon refractus*, *Echinopogon ovatus* and *Lepturus repens* were recorded in the diary of Allan Cunningham in 1830, 42 years after settlement; each is regarded as indigenous to the island. *Bothriochloa macra* on the other hand, is considered to be introduced, Green (1994) commenting that it was 'introduced to the island as a pasture grass'. The species was apparently first recorded on the island in 1902 by Maiden (1904). This may seem a late record for an indigenous species, after 114 years of settlement, but no botanist is known to have visited the island between 1830 and 1902, so the grass could have easily been overlooked. Cunningham listed only five species of grass, so his list cannot be regarded as comprehensive. It is unlikely to have been introduced as a pasture grass, as suggested by Green (1994), as the species is regarded as being rather unpalatable to stock (e.g. Lamp et al. 1990).

Table 1. Status of plant species on Norfolk Island discussed in this paper

Species	Growth habit	Earliest record	Current Status/Opinion Key Reference(s)
Bothriochloa macra	Grass	1902	INTRODUCED Maiden (1904); Green (1994)
Cymbopogon refractus	Grass	1830	INDIGENOUS Cunningham (1830); Green (1994)
Delarbrea paradoxa	Tree	unknown	CONSIDERED AN INTRODUCED WEED. Green (1994)
Dicranopteris linearis	Fern	1995	ONE LOCATION, CONSIDERED INDIGENOUS. Braggins (1996); Lange et al. (2005)
Echinpogon ovatus	Grass	1830	INDIGENOUS. Cunningham (1830); Green (1994)
Homalanthus populifolius	Tree	1902	INTRODUCED FROM LORD HOWE ISLAND. Maiden (1904); Green (1994)
Ileostylus micranthus	Shrub	1930s	INDIGENOUS AND LISTED AS VULNERABLE. Green (1994)
Ipomoea alba	Creeper	c.1792	INTRODUCED. Paterson/Doody (c.1792); Green (1994)
Ipomoea cairica	Creeper	c.1792	STATUS INCONCLUSIVE. Paterson/Doody (c.1792); Green (1994); Lange et al. (2005)
Ipomoea indica	Creeper	c.1792	INTRODUCED. Paterson/Doody (c.1792); Green (1994)
Lepturus repens	Grass	1830	INDIGENOUS. Cunningham (1830); Lange et al. (2005)
Paspalum distichum	Grass	2007	INTRODUCED (?), Mills (2007)
Phormium tenax	Large herb	1774	MOSTLY CONSIDERED AS INDIGENOUS. Green (1994); Mills (2009); Coyne (2009a)
Sonchus oleraceus	Herb	1830	INTRODUCED. Cunningham (1830); Green (1994)
Typha orientalis	Reed	2,000 yrs bp	INDIGENOUS; RECORDED IN POLLEN IN SWAMP AT KINGSTON. Green (1994); Macphail et. al. (2001)

In 2007, the wetland grass *Paspalum distichum* was discovered on Norfolk Island (Mills 2007). The grass was found to be quite common on some low-lying, moist paddocks in the western part of the island. The species could have been transported by waterbirds, which regularly visit the island; this could have been recent or the species could have been present for many years. The grass could easily have been overlooked amongst the dense, heavily grazed grass sward in which it grows. Perhaps significantly, the grass is reported as introduced to the Kermadec Islands (Sykes & West 1996), located at the same latitude as Norfolk Island and about 1400 km to the east.

Discussion and Conclusion

The comment by Laing (1914) is no less apt today than when he visited Norfolk Island in 1912: 'one may feel comparatively sure that the list of Norfolk Island species has been stuffed with aliens; but when it comes to examining the title of any particular species to appear, difficulties are in most cases encountered'.

The lists of indigenous and introduced plants on Norfolk Island are constantly changing; new species arrive, taxonomic studies modify our understanding of species resulting in name changes and status, and historical studies can turn up more information. The number of species documented in the *Flora* of 1994 is 171 indigenous and 274 introduced (Green (1994); the figures in 2010 are respectively, 181 and 378 species (Mills 2010).

The examples cited above from Norfolk Island illustrate the problem of categorising species as indigenous or introduced (Table 1). Early botanical collections, descriptions and drawings, and even rather obscure journal notes can identify if a species was present on the island at the time of first European contact. Caution is always required, as in the case of *Ipomoea cairica*, and where ambiguous names are used. Palynological studies can confidently confirm the presence of some species but must be cautiously used to determine the absence of a species, as shown in the case of *Phormium tenax* (Mills 2009). Inconsistency between the approach taken to species that can be proven to be of the same status is inexplicable. One can contrast the approach to *Delarbrea paradoxa* to that of *Ileostylus micranthus* and *Dicranopteris linearis*. While the tree *Delarbrea* is regarded as a weed to be eradicated, the mistletoe is a listed threatened species and the fern is considered indigenous.

For species of uncertain status, future investigations as to their indigenous status may or may not reach a firm conclusion. Careful research, ranging from close study of historical material, including early collections, palynological investigations and possibly DNA analysis, can establish without doubt the indigenous status of most plant species in places like Norfolk Island. However, there will inevitably be some species that cannot confidently be placed in the indigenous category. This can pose a dilemma for the manager of a protected area if a problematic species is invasive and negatively impacting upon other species. Such is the case with *Ipomoea cairica* and, potentially, *Delarbrea paradoxa*. These species have usually been treated as weeds and control measures implemented. This paper does not offer an absolute solution to the problem, but suggests that there must be a consistent approach. With this in mind, it is suggested that *Delarbrea paradoxa* be treated as indigenous. *Ipomoea cairica* is abundant on the island and control measures will never result in its local demise. As this rampant creeper can smother other vegetation, its control can perhaps be justified in areas where rainforest regeneration is being promoted, even if it is indigenous.

The issue of indigenousness is more important than idle botanical curiosity. Introduced plants or weeds are a major area of activity for the managers of protected natural areas. Introduced plants are considered detrimental to natural values, and depending upon their invasive nature, are targeted in weed control programs. The manager can face a dilemma if there is controversy over the indigenous status of a species. The flora of most regions contains indigenous species that have a weedy habit; such species specialise in colonising disturbed areas and are often short-lived. The reserve manager is not as interested in subtle arguments over an indigenous verses a non-indigenous status as in knowing whether control measures are required. Among other things, this can have budgetary implications.

Establishing the Norfolk Island status of the species discussed here would assist the manager of the national park and other public reserves in deciding upon resource allocation; if a plant is indeed indigenous then it should not require control. As we have seen, the dilemma for the land manager may not be readily resolved. Unless the species is a particularly invasive plant, then the matter is not likely to be of great importance. The problem arises if the species is an aggressive species that expands at the expense of other indigenous species and has a negative impact on habitat values. In the case of Norfolk Island, should the tree *Delarbrea paradoxa* be accepted as indigenous and allowed to grow and expand? Consistency of approach suggests that it should. Based on the listing of *Ileostylus micranthus* it could even be a candidate for threatened species listing.

Several species of bird have 'self-introduced' to Norfolk Island since European settlement; these are today regarded as native species (Christian 2005), even though they may only have been able to successfully colonise the island because of the open habitats made available following clearing of the original forest. Should we consider self-introduced plants any differently?

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SHORT COMMUNICATION

The green-leaved variant of *Eucalyptus largiflorens*: a story involving hybridization and observant local people

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Abstract: *Eucalyptus largiflorens* (Black Box) is the most common tree in the Chowilla anabranch system on the Murray River floodplain. It typically has dull, glaucous, grey-green leaves. Occasional trees with smaller, glossy green leaves (Green Box) occur scattered amongst the Black Box. In areas with increasing salinity, they usually appear much healthier than adjacent, normal Black Box trees. Green Box plants are intermediate between normal *Eucalyptus largiflorens* plants and *Eucalyptus gracilis* plants in many morphological and allozyme characters, strongly suggesting that they are hybrids between those species. Green Box plants tolerate salinity better and use water more conservatively than normal Black Box plants, traits that they have probably inherited from *Eucalyptus gracilis*.

In 1994, the Botanic Gardens of Adelaide used tissue culture and micropropagation to produce nearly 9,000 cloned Green Box plants which were planted out on Riverland floodplains. Since the 1990s, the high cost of producing clonal plants has meant that no further such plantings have occurred. Because Green Box plants can be a considerable distance from the nearest plants of one putative parent (*Eucalyptus gracilis*), more detailed studies could contribute to the existing work on such phantom hybrids.

Cunninghamia (2010) 11(4): 415–418

Introduction

Although a green-leaved variant of *Eucalyptus largiflorens* is mentioned in 'Trees for Saline Landscapes' (Marcar & Crawford 2004), it has never been dealt with in any mainstream taxonomic literature. However, the story of the discovery of this variant and the subsequent research on its evolution, physiology and use in saline landscapes is instructive in a number of ways and deserves to be more widely known. In this note, we bring together the sparse, widely-scattered literature to produce a summary of the topic. For brevity, we follow Nicholls (2009) in referring to the variant as Green Box. Plant nomenclature follows Chippendale (1988).

The Green Box Story

On the floodplain of the Murray River in the Chowilla anabranch system in southwestern New South Wales and eastern South Australia, the most common tree is *Eucalyptus largiflorens* (Black Box) (Zubrinich *et al.* 2000); it normally occurs upslope on less-flooded sites than *Eucalyptus camaldulensis* (River Red Gum) (Mensforth *et al.* 1994). Since European settlement, many of the floodplain eucalypts are dying because of rising saline groundwater and reduced flooding frequency (Zubrinich *et al.* 2000).

Typical trees of *Eucalyptus largiflorens* have dull, glaucous, grey-green leaves. While travelling through a stand of them on Chowilla Station in the mid 1930s, Dudley Foweraker, a nurseryman from Renmark, noticed a box-barked tree with smaller, glossy green leaves (Nicholls 2009). Later, in the 1970s, Janyce Frahn of Paringa noticed a similar tree on the nearby Pike River floodplain (Nicholls 2009). More of these Green Box trees turned up in a 1982 Society for Growing Australian Plants survey which was part of the Pike River Management Plan. Then, in 1989, Denis Frahn, a farmer and fruit grower from Paringa, showed one of the trees to the late Jack Seekamp, an agricultural scientist and fruit grower from Renmark (Nicholls 2009). Because Green Box trees usually appear much healthier than adjacent Black Box ones, Seekamp was quick to start studying them in the field and to alert others to their possible significance (Nicholls

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2009). As a result, in 1992, one of us (TMZ) started her Ph.D. candidature at the Flinders University of South Australia under the supervision of Professor S.D. Tyerman and Dr. Molly Whalen to investigate the origin of Green Box and to determine its ability to cope with shallow, saline groundwater compared to the common form of Black Box (Zubrinich 1996).

This work established that Green Box trees have now been found on floodplains from at least as far east as Moulamein and Deniliquin in southwestern New South Wales and west to Sedan near Blanchetown in South Australia. They have also been recorded in Victoria along the Murray River as far upstream as Boundary Bend (Seekamp 1990–1994). They are much less common than normal Black Box trees, occurring as occasional, scattered trees in what appears to be normal Black Box habitat (Zubrinich 1996).

Detailed studies of adult and seedling morphology showed that Green Box plants are intermediate in many cotyledon, leaf, bark, flower and fruit characters between *Eucalyptus largiflorens* and *Eucalyptus gracilis* (White Mallee) and so are considered to be hybrids between those two species (Zubrinich *et al.* 2000). A large-scale allozyme analysis also provided substantial evidence that Green Box plants are hybrids between those species (Zubrinich 1996). A later Ph.D. project using AFLP DNA markers also supports that view (Koerber 2004).

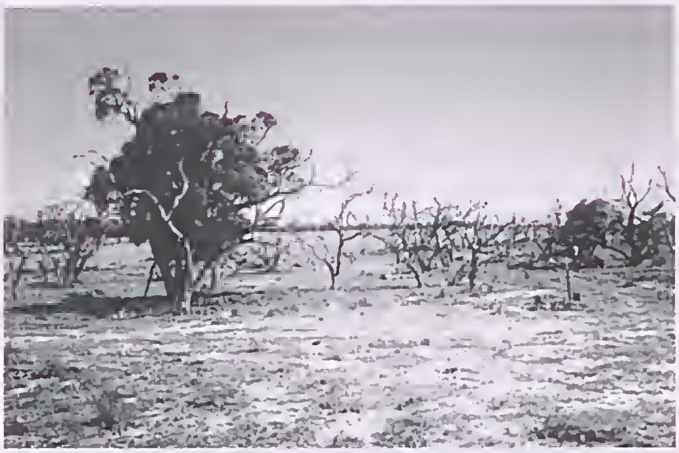

Fig. 1. Murray floodplain at Tareena Station, New South Wales. Live Green Box tree with dead *Eucalyptus largiflorens* trees nearby. Photo by J.V. Seekamp, 29 January 1999.

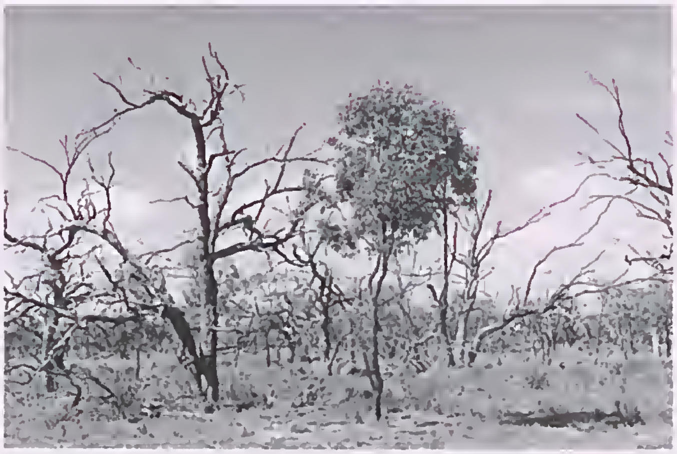

Fig. 2. Murray floodplain at Coombool Inlet, South Australia. Live Green Box tree with dead *Eucalyptus largiflorens* trees nearby. Photo by J.V. Seekamp, 3 October 1994.

An important character is that while *Eucalyptus largiflorens* has all stamens fertile, *Eucalyptus gracilis* has an outer ring of staminodes (filaments lacking anthers). Green Box resembles *Eucalyptus gracilis* in usually having an outer ring of staminodes, but with fewer staminodes in total than *Eucalyptus gracilis* (Zubrinich 1996).

Eucalyptus gracilis is a mallee (i.e. a tall shrub with many stems arising from an underground lignotuber) or tree found on non-flooded, well-drained, calcareous soils adjacent to the Chowilla floodplain and elsewhere (Zubrinich *et al.* 2000). *Eucalyptus largiflorens* and *Eucalyptus gracilis* are both from subgenus *Symphyomyrtus*, so that hybridization between them is not unexpected (Potts & Wiltshire 1997). However, they are members of different sections within the subgenus and are apparently only remotely related (Pryor & Johnson 1971). Hybridization between a tree species and a mallee species, as in this case, is known in many other cases (D. Nicolle pers. comm.).

Eucalyptus largiflorens can flower opportunistically more than once a year, depending on flooding and rainfall. *Eucalyptus gracilis* has a shorter flowering period with a different peak, but some synchronous flowering occurs, with a lot of overlap (Zubrinich 1996). Because *Eucalyptus gracilis* has larger flowers with longer styles than *Eucalyptus largiflorens* (while Green Box is intermediate in those characters), it may be unlikely that the pollen tube of *Eucalyptus largiflorens* can grow the full length of the style of *Eucalyptus gracilis*. If so, hybridization may only occur when *Eucalyptus largiflorens* is the maternal parent (Zubrinich 1996) as in the very similar case described by Gore *et al.* (1990). The Green Box trees are more variable than their putative parents in a number of adult leaf and fruit characters (Zubrinich 1996).

Detailed ecophysiological studies showed that Green Box tolerates saline conditions better than normal Black Box plants. Its more conservative water use, and ability to operate at lower water potential, may underlie its superior performance on the floodplain under present conditions (Zubrinich *et al.* 2000).

Some of the larger Green Box trees obviously pre-date European settlement, but it is clear that their numbers have increased through time, especially in the season following the 1956 floods (Seekamp 1999). Details are lacking about the extent to which established Green Box trees are producing seed and contributing to the spread of Green Box. By 1999, there were floodplain areas (e.g. near Tareena) carrying healthy Green Box trees but where nearly all of the *Eucalyptus largiflorens* trees were dead (Seekamp 1999, Fig. 1, Fig. 2).

Under pre-European conditions, the *Eucalyptus largiflorens* habitats on the floodplain were generally more favourable for plant growth than the adjacent non-flooded *Eucalyptus gracilis* habitats because of the extra water they received from floods. Thus, it is not surprising that Zubrinich (1996), in her seedling experiments, recorded faster, genetically-determined growth rates in *Eucalyptus largiflorens* than in *Eucalyptus gracilis*, probably caused by selection for conservative water use in the latter (Parsons 1968). The Green Box seedling growth rates were slower than normal Black Box, a feature presumably inherited from *Eucalyptus gracilis* (Zubrinich 1996).

In areas more distant from the Murray River, there are salt-affected sites which carry eucalypts in non-floodplain areas near the margins of salt lakes and saltpans. The predominant eucalypt on such sites is *Eucalyptus gracilis* (unpublished data; see also Rowan & Downes 1963 p. 54 and Rowan 1971 p. 21). Thus it is likely to be the most salinity-tolerant eucalypt native to this part of Australia. This notion is supported by Barrett *et al.* (2005), who found that it tolerated high leaf salt concentrations, with summer sodium concentrations as high as or higher than those reported for any other eucalypt. Of the species of subgenus *Symphyomyrtus* adjacent to the floodplain (*Eucalyptus gracilis, oleosa, porosa* and *socialis;* Zubrinich 1996), morphology and flowering time suggest *Eucalyptus gracilis* as the species involved in the present story. In addition, its high salinity tolerance may make it the most likely local eucalypt to confer extra salt tolerance on *Eucalyptus largiflorens* by hybridizing with it.

Turning to the efforts to produce Green Box progeny for revegetation of sites losing their Black Box trees to rising salinity, as early as March 1991 the South Australian Woods and Forests Department plant nursery at Murray Bridge was raising seedlings using seed from Chowilla Green Box trees, as were students at Glossop High School in 1992 and 1993 (Seekamp 1990–1994). Such seedlings segregate into a wide range of plant types, many of which do not become green and have low survival and very slow growth (Seekamp 1999). Possibly for this reason, in 1993 the Botanic Gardens of Adelaide began to study the possibility of cloning Green Box by micropropagation. Eventually, clones were established from epicormic shoots from five trees. A grant of $15,000 from the Murraylands Conservation Trust enabled mass propagation from these to finally produce 8,819 acclimatised and hardened-off young plants by October 1994 (Botanic Gardens of Adelaide 1993, 1994, 1995).

These tissue-cultured plants were then planted out by community groups and school children ‘onto the floodplains throughout the Riverland’ (Nicholls 2009) including Chowilla Game Reserve and Banrock Station (Michael Harper pers. comm.) where they are said to be ‘magnificently green and healthy amongst the dying Black Box’ (Nicholls 2009). When planted above fresh water tables in Renmark parking lots, nature strips and gardens, the Green Box clonal plants ‘grew rapidly into attractive and shapely trees’ (Seekamp 1999). At least some of this batch of clonal plants were planted out as early as 1994 (Seekamp 1999).

In 1994 the Botanic Gardens of Adelaide sent cultures from four Green Box trees to Biotech Plants Pty Ltd at Somersby, New South Wales, who had a contract from the Murraylands Conservation Trust (MCT) to supply 20,000 cloned plants (Botanic Gardens of Adelaide 1995). It seems certain that no plants were produced (Michael Harper pers. comm.) This is hard to confirm because the company is now defunct; the MCT is also defunct and its records have disappeared (Michael Harper pers. comm.) It is thought that a final batch of clonal plants was produced by a Hobart company in the late 1990s, but again records are lacking (Michael Harper pers. comm.).

In 1999, Seekamp wrote ‘the current recipe for producing Green Box rootlings by tissue culture has a low survival rate through the process and commercial production would only be possible at a prohibitive price per plant.’ This is supported by workers currently involved in revegetation work; the high cost of producing limited numbers of plants (e.g. 1–2,000) is the only reason that no clonal plants have been planted in the Riverland since the 1990s (Michael Harper pers. comm.). Seekamp believed that more research would solve this cost problem (Seekamp 1999). In any case, any future revegetation work using large numbers of Green Box needs to consider both their long-term regeneration prospects and their possible long-term genetic effects on *Eucalyptus largiflorens*, as well as the advisability of using large numbers of plants cloned from a few parent trees compared to using seedlings.

Seekamp had pointed out that there were both ‘rounded and vertical-growing types’ of Green Box and had hoped to use cloned plants from rounded mother trees for shade and as widely-spaced plantings on degraded floodplain and those from vertical-growing mother trees in plantations for firewood, trellis posts and sawn timber (Seekamp 1999).

While writing this paper our enquiries failed to identify anyone currently selling Green Box seed or raising Green Box seedlings.

Apart from a mention in passing in Barrett *et al.* (2005) and the brief summary in Nicholls (2009), the only published reference to Green Box we can find since Zubrinich *et al.* (2000) is a record of it from Penfolds Lagoon 6 km downstream from Morgan (Marsland & Nicol 2009).

Concluding Discussion

The Green Box story raises a number of general issues. Firstly, it helps to exemplify the important role that observant local farmers and naturalists have played in research on Australia’s plants, a point that is clear from papers like that of Willis (1975) and from the body of work published since the late nineteenth century in journals like the South Australian Naturalist and the Victorian Naturalist.

Secondly, further study of the Green Box story may shed light on important evolutionary issues related to the subject of phantom hybrids, namely hybrids that are geographically isolated from one or both putative parents (Pryor & Johnson 1971). While Green Box plants co-exist on the floodplain with one putative parent, populations of the other one, *Eucalyptus gracilis*, are usually more than three km from the floodplain and frequently much further away (Zubrinich 1996).

Using the *Eucalyptus gracilis* distribution data in Australia's Virtual Herbarium, it seems that the record of Green Box from Deniliquin (Zubrinich 1996) could easily be at least 50 km from the nearest *Eucalyptus gracilis* population. Furthermore, Seekamp (1990–1994) records Green Box from 'along the Darling up as far as Bourke' which could be much further from *Eucalyptus gracilis* plants. This aspect of Green Box biology needs careful checking and intensive work for the light it might shine on important issues like eucalypt gene flow via pollen and seed (Potts & Wiltshire 1997).

Furthermore, the present unusual case of a parent species dying on a large scale from anthropogenic causes, leaving behind only its hybrid progeny deserves further work to help elucidate crucial current issues in the study of hybrid speciation, adaptive divergence and other evolutionary processes (see e.g. Donovan *et al.* 2010). In the present story, given the prominence and importance of hybrids that may stabilize and become species, it can be argued that Australian herbaria should encourage taxonomists to provide a level of formal recognition for natural hybrids.

Finally, it would be valuable for the people responsible for policy and funding related to the rehabilitation of degraded Black Box country in New South Wales, South Australia and Victoria to discuss what role there is for Green Box and what funding and research are needed as a consequence.

Acknowledgements

It is a pleasure to thank Trevor Edwards, Stephen Forbes and his staff at the Botanic Gardens of Adelaide, Denis Frahn, Mike Harper, Susan Hoebee and Dean Nicolle for a great deal of help. We especially thank Teresa ter Bogt of the McCormick Centre of the Australian Landscape Trust for very kindly selecting and sending us extracts from the seven volumes of Jack Seekamp material held there.

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SHORT COMMUNICATION

On the distribution, ecology and conservation status of three rare plant taxa *Zygophyllum compressum*, *Elachanthus glaber* and *Eremophila crassifolia* in southwestern New South Wales.

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Abstract: The arid and semi-arid southwest of New South Wales has received disproportionately less attention from botanists than other similar-sized geographic regions of the state. Recent work has extended our knowledge of three extremely rare plant taxa from this part of the state. *Zygophyllum compressum* (Zygophyllaceae) and *Elachanthus glaber* (Asteraceae) are restricted to gypseous rises within active saline groundwater discharge complexes with limited distribution in southwest New South Wales and occur within the plant community "Gypseous shrubland on rises and semi-arid plains" (ID253) which is listed as threatened (vulnerable) within the state. *Eremophila crassifolia* (Myoporaceae) is restricted to a few plants on a roadside and adjacent mallee vegetation approximately 35 km east of Wentworth. Based on IUCN criteria it is suggested that *Eremophila crassifolia* is critically endangered and *Zygophyllum compressum* and *Elachanthus glaber* endangered in New South Wales and all should be listed under the NSW *Threatened Species Conservation Act* 1995.

Cunninghamia (2010) 11 (4): 419–424

Introduction

During rare plant and baseline flora surveys in southwest New South Wales, the author has recorded three new or rare plant taxa for the state: *Zygophyllum compressum* (J.M. Black) (Zygophyllaceae), *Elachanthus glaber* and *Eremophila crassifolia*. This paper uses the distribution, ecology and conservation status of these species in New South Wales to provide cases for potential listing under the NSW *Threatened Species Conservation Act* 1995.

The conservation status of plant taxa occurring at the regional or state level follow the criteria outlined in IUCN (2001) and terms such as population and subpopulation follow definitions as outlined there. The IUCN conservation status categories and criteria for listing have been generally accepted by Australian state conservation agencies vested with assigning conservation status and hence have been adopted in this paper.

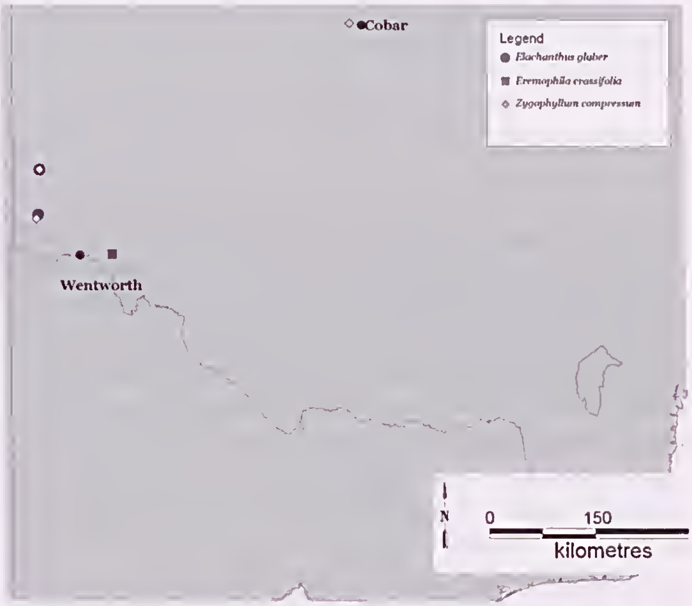

Fig. 1. Distribution map for *Zygophyllum compressum*, *Elachanthus glaber* and *Eremophila crassifolia* in New South Wales.

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Zygophyllum compressum J.M. Black (family Zygophyllaceae)

Distribution

Zygophyllum compressum (Rabbit-ears Twin-leaf) is a short-lived, ascending, to sometimes procumbent annual that grows to 35 cm. It appears after rainfall and has a wide distribution in Australia, in the semi-arid or arid climate zones in far northwest Victoria, South Australia, Western Australia and Northern Territory.

For New South Wales, Australia's Virtual Herbarium (AVH) currently (3/8/2010) lists two herbarium records for *Zygophyllum compressum*: a collection from approximately 16 km west-north-west of Cobar (by G. Lithgow on 19/12/1974, HO542716) and one from a saline discharge complex at Nulla Nulla Station approximately 75 km northwest of Wentworth (by the author on 06/12/2001 MEL2274406A). A third specimen was collected on 23/8/2010 from the Scotia groundwater discharge complex (Ferguson *et al.* 1995) at the University of Ballarat's field research station at Nanya, 135 km north-north-west of Wentworth. This specimen (NSW866696) was submitted by the author to the National Herbarium of New South Wales. The known New South Wales distribution of *Zygophyllum compressum* is shown in Fig. 1.

Ecology

The following account is based on the author's collection sites at the Nulla Nulla and Scotia saline discharge complexes or boinkas (Macumber 1991) in the far southwest of NSW. No information has been obtained for the collection from near Cobar.

Zygophyllum compressum (Figs. 2 & 3) is restricted to gypseous plains and low gypseous rises within currently active groundwater discharge sites such as occur at Nulla Nulla and Nanya Stations. From rare plant monitoring work in northwest Victoria conducted by the author, *Zygophyllum compressum* plant numbers at known sites can vary appreciably depending upon the amount of rain received in the winter months. The gypseous soils present are of Yamba Formation (Firman 1969) origin and of Late Pleistocene to Holocene age. The gypsum, present as powder or in the crystalline form, is an evaporite residue left after saline brines have been discharged and dehydrated through evaporation at the natural ground surface. The chemistry and pH of the saline groundwater normally present within 1–3 m of the natural surface varies from location to location across the Murray-Darling Basin and in turn influences the chemistry of the evaporite that forms (Macumber 1991).

The gypsum on saline groundwater discharge complexes has often been re-worked, by the forces of prevailing winds, into hummocks and dunes of irregular shape. Yamba Formation gypseous deposits in southwest New South Wales usually occur within NSW Vegetation Classification plant community ID253 "Gypseous shrubland on rises and semi-arid plains" (Benson *et al.* 2006) which are considered vulnerable in the state with a pre-European and current extent of just 2,000 ha and 1,400 ha respectively. The deposits at the Nulla Nulla site occurs within an ecotonal variant of the above plant community with gypseous soils, but closely associated with plant community ID64 "Samphire – Water Weed – Sea Heath shrubland of saline depressions of the arid and semi-arid (warm) zones" (Benson *et al.* 2006).

At the Nulla Nulla boinka (in December 2001) *Zygophyllum compressum* occurred in three main areas covering approximately 20 ha in total with only 50 individuals present (Sluiter 2001). Winter 2001 in southwest New South Wales was a particularly dry time, and may have been a reason for the low numbers of plants found over a relatively large search area of suitable habitat. At all three locations, the

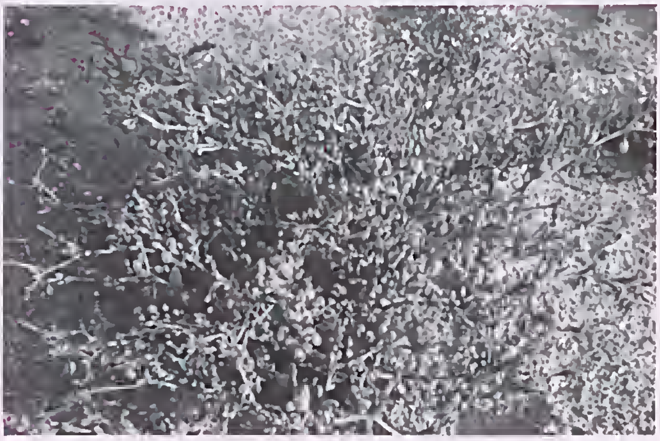

Fig. 2. *Zygophyllum compressum* plant growing on a gypseous rise at Nanya Station, 135 km north-north-west of Wentworth in far southwest New South Wales. Photograph Ian Sluiter 23/08/2010.

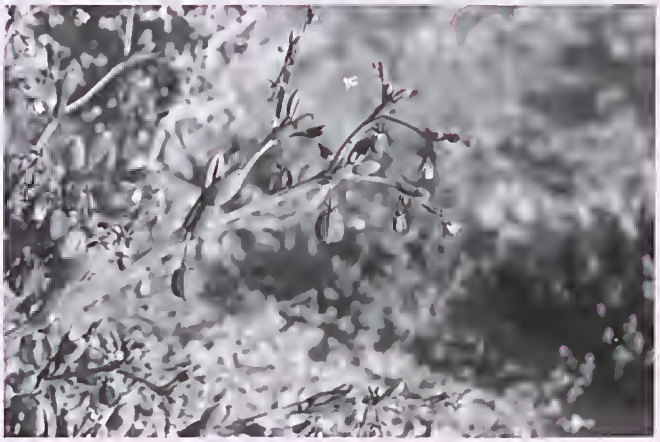

Fig. 3. Close-up of flowers and fruit of *Zygophyllum compressum* from Nanya Station in August 2010. Photograph Ian Sluiter 23/08/2010.

species was growing on low, gypseous plains often with small rises up to 30 cm above the surrounding landscape. It was found in very open low shrubland (see Fig. 4) dominated by *Halosarcia pergranulata*), in association with *Frankenia foliosa*. Other species found at some, but not all Nulla Nulla localities, include *Lawrencia glomerata*, *Eragrostis falcata*, *Maireana appressa* and *Elachanthus glaber*. Salt crystals deriving from the underlying saline groundwater were often present as efflorescence on very low raised ridges and cracks of the ground surface. Sluiter (2001) estimated that up to 1,000 *Zygophyllum compressum* plants may be present at the Nulla Nulla Boinka, with not all potentially suitable habitat searched.

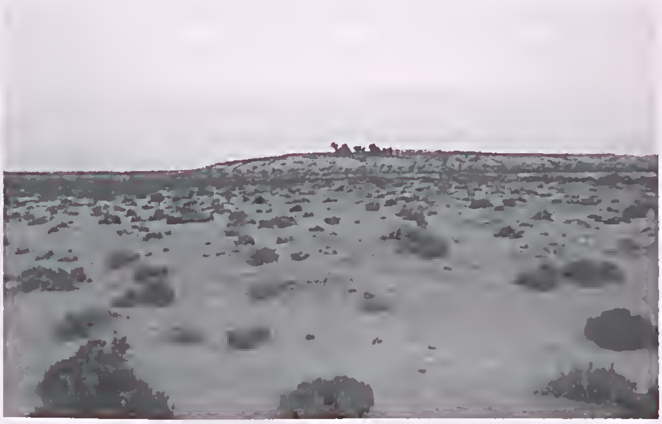

Fig. 4. *Zygophyllum compressum* and *Elachanthus glaber* habitat at Nulla Nulla Station. The species grows on low gypseous rises 20–30 cm above the surrounding plain. Here the gypseous rises appear as the darker patches between the surrounding halophytic shrubs including *Halosarcia pergranulata* and *Frankenia foliosa*. Photograph Ian Sluiter 13/12/2001.

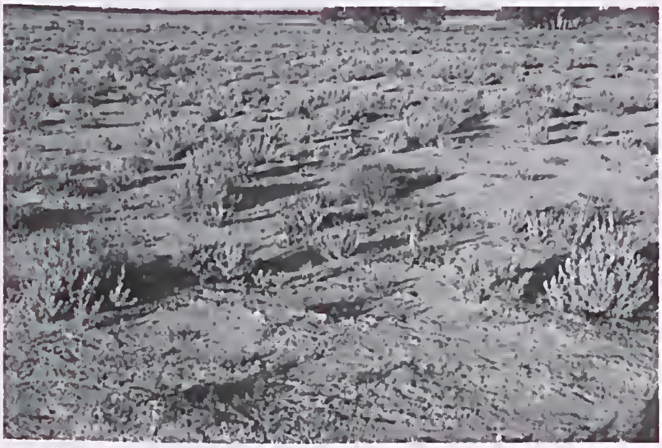

Fig 5. *Elachanthus glaber* growing on a copi or gypseous rise at Nanya Station 135 km north-north-west of Wentworth, in southwest New South Wales. Photograph Ian Sluiter 23/08/2010.

At the Scotia boinka at Nanya (in August 2010) approximately 100 individuals of *Zygophyllum compressum* occurred over a 1 ha area on a gypseous rise elevated approximately 2.5 m above a surrounding saline playa lake. The vegetation at the Nanya site was dominated by *Atriplex vesicaria* in association with *Frankenia foliosa*, *Lawrencia glomerata* and *Elachanthus glaber*. (see Fig. 5). Time constraints prevented further targeted search effort in potentially suitable habitat at the Scotia boinka. It is considered likely that further searches would reveal more plants at the Scotia sub-population because the area is known to contain substantially more suitable habitat than was searched in August 2010.

An estimate of the total population at each of the two sites is estimated to be 1,000 ± 200 individuals. This may put the total New South Wales population at less than 2,000 individuals.

Threats to the species include grazing (most plants at the Nulla Nulla Boinka were browsed by stock and/or rabbits in 2001), rising saline groundwater, and prolonged drought, which has occurred within the Lower Murray-Darling Catchment for much of the past 16 years. Nulla Nulla Station has a high rabbit grazing presence, but stock have not grazed the saline discharge area since January 2009. Rising saline groundwater has occurred in the vicinity of Lake Victoria due to the influence of permanent storage of fresh water in the lake over the past 80 years. This has resulted in the development of a groundwater mound 4 m higher than normal beneath and immediately around the water body (Nolan-ITU 1997). It is not known how this has impacted the Nulla Nulla boinka 28 km to the north, but it is reasonable to assume that there has been some watertable rise. A further rise of 0.5–1 m in groundwater level at the Nulla Nulla boinka could severely threaten the *Zygophyllum compressum* population there due to its local dependence on land of elevation approximately 1 m above regional groundwater.

Conservation status

There are three known sites for *Zygophyllum compressum* in New South Wales with a maximum known area of occupancy estimated at < 50 ha and an estimated number of 2,000 plants. Although extremely restricted in New South Wales, not all habitat within plant community ID253 Gypseous shrubland on rises and semi-arid plains is potentially suitable habitat. The species has a particular preference for gypseous plains and low rises with very open vegetation structure elevated between 1–3 m above saline regional groundwater. The species:

- has an extent of occurrence and area of occupancy in NSW of < 500 km^2 = IUCN B2
- is severely fragmented (three subpopulations separated by 480 km) = IUCN B1a and B2a
- has extreme fluctuations in the area of occupancy at the Nulla Nulla subpopulation = IUCN B2eii

- has extreme fluctuations in the number of mature individuals at the Nulla Nulla subpopulation based on prolonged drought associated with climate change = IUCN B2civ
- has a total population estimate of < 2,500 individuals = IUCN C

Based on satisfying IUCN criteria B1a, B2a, B2c ii and iv; and C, *Zygophyllum compressum* is considered to be endangered in New South Wales and eligible for listing under the NSW *Threatened Species Conservation Act*. *Zygophyllum compressum* is also considered to be vulnerable in adjoining northwest Victoria (DSE 2005). although this status may be elevated after a formal review of the status of this taxon using IUCN criteria which is currently underway (David Cameron from the Arthur Rylah Research Institute, VIC, personal communication).

Elachanthus glaber *Paul G. Wilson in H. Eichler (family Asteraceae)*

Distribution

Elachanthus glaber (Shiny Elachanth) (Fig. 6) is a small, glabrous green or yellowish-green herb to 10 cm tall (Walsh & Entwisle 1999). It is known from ~10 sites in northwest Victoria and two in South Australia, the SA sites both occurring west of Port Augusta on the northern Eyre Peninsula. In both Victoria and South Australia, *Elachanthus glaber* is considered to be rare (DSE 2005; NPWS 2008). It is listed as an Australian rare or threatened plant taxon with a conservation code of 3RC- (Briggs & Leigh 1995).

Three sites are known from New South Wales (Figure 1). Two sites have been recorded by the author, the Nulla Nulla boinka approximately 75 km northwest of Wentworth, on 6/12/2001 (MEL2274976A), and the Scotia boinka at Nanya on the 23/8/2010 (NSW866698-National Herbarium of New South Wales) (records from AVH as of 3/8/2010). Westbrooke *et al.* (1998) also recorded the plant species from the Scotia 1:100,000 Map Sheet area of southwestern New South Wales, occurring on an island within the saline discharge complex in close proximity to the collection site of the author. It does not show at the scale of mapping on Fig. 1.

Ecology

Like *Zygophyllum compressum* above, *Elachanthus glaber is* found in association with the Nulla Nulla and Scotia boinkas, and has a very similar ecology in that it is largely dependent on gypseous substrates with a relationship with saline brines in the underlying sediments. Observations by the author in the range of the species in northwest Victoria suggest *Elachanthus glaber* may be more tolerant of a wider range of edaphic conditions within gypseous substrates than *Zygophyllum compressum*. At the Cowangie boinka, south of Murray-Sunset National Park in northwest Victoria, the species grows on more elevated gypseous rises and hummocks, as well as on low gypseous rises and plains, suggesting the species may be tolerant of a wider range of soil salinities and gypsum content.

Conservation status

At the Nulla Nulla site *Elachanthus glaber* was estimated to occur over 200 ha with about 2,000 plants in December 2001. At the Scotia site approximately 200 plants were observed over approximately 20 ha in August 2010, although there may have been more on suitable substrate elsewhere in the area. The species:

- has an extent of occurrence in NSW of < 5,000 km^2 = IUCN B1
- has an area of occupancy in NSW of < 500 km^2 = IUCN B2
- is known from only two subpopulations = IUCN B1a and B2a
- suffers extreme fluctuations in the number of mature individuals at both subpopulations based on prolonged drought associated with climate change = IUCN B1eiv

Based on satisfying IUCN criteria B1, B1a, and B1eiv; and B2, B2a and B2eiv *Elachanthus glaber* is considered to be endangered in New South Wales and eligible for listing under the NSW *Threatened Species Conservation Act*

Eremophila crassifolia *(F. Muell.) F. Muell. (family Myoporaceae)*

Distribution

Eremophila crassifolia (Thick-leaf Emu-bush) is a low spreading shrub 0.2–1m tall, frequently root suckering, with lilac coloured flowers (Chinnock 2007). The species is restricted to mallee vegetation communities in the Murray-Darling Depression IBRA including northwest Victoria and adjoining parts of South Australia; and the Eyre-Yorke Block Bioregion of South Australia and is extremely widespread and common on the Eyre Peninsula (Chinnock 2007). In Victoria, the species is listed as rare (DSE 2005).

On 10/12/2004 the author recorded approximately 20–30 plants of *Eremophila crassifolia* growing on a roadside and in neighbouring strip of remnant vegetation in sandplain mallee vegetation northeast of Trentham Cliffs, 35 km east of Wentworth in New South Wales. The local area, apart from a narrow band of mallee vegetation adjacent to a road, had been largely cleared for cereal production under an approved Clearing and Cultivation Licence shortly before the site was visited. This collection (MEL2269880A – Accession Number NSW593893) is the only record for the species in New South Wales (AVH as of 3/8/2010) (Figure 1).

At the New South Wales site near Trentham Cliffs, *Eremophila crassifolia* (Fig. 7) was recorded in a relatively flat sandplain with 'whipstick' mallee vegetation dominated by *Eucalyptus dumosa*, *Eucalyptus socialis*, *Eucalyptus gracilis* and *Eucalyptus oleosa* with a sparse *Triodia scariosa* understorey (Fig. 8). Plants were typically 40–60 cm high perennial shrubs typically separated by 20–30m. No evidence of root suckering was evident amongst plants within the remnant mallee vegetation but sporadic shrubs in an adjoining roadside verge which had been previously cleared were possibly root suckers based on their regrowth from previously cleared land. The plant community can be considered ecotonal between plant communities ID170 "Chenopod sandplain mallee woodland/shrubland of the arid and semi-arid (warm) zones" and ID171 "Spinifex linear dune mallee mainly of the Murray-Darling Depression Bioregion" (Benson *et al.* 2006). Topsoil at the site is a light sandy clay loam of Woorinen Formation (Lawrence 1966) origin with a B horizon of calcrete at 40 cm depth.

Conservation status

Based on current knowledge, *Eremophila crassifolia* in New South Wales is restricted to one very small (< 10 ha) patch of mallee vegetation and an adjoining cleared roadside. It is highly likely that the species would also have occurred on land adjacent to the remnant patch which was being prepared for cereal cropping. In New South Wales, *Eremophila crassifolia*:

- occurs in a single population of < 50 mature individuals with an area of occupancy and extent of occurrence in NSW of < 10 km^2 = IUCN B1a, B2a, B1ci, B1cii, B1civ, B2ci, B2cii, B2civ, C, C2ai, C2aii and D
- is anticipated ("inferred, projected or suspected") to have experienced severe (≥80%) decline in population numbers in the last 10 years through habitat loss associated with permits to clear for cultivation – particularly as surrounding land is now cropped on a permanent basis = IUCN A2, A4
- is likely to have suffered a decline ("inferred or projected") in the extent of occurrence, area of occupancy and the number of mature individuals as a result of extensive clearing of its habitat = IUCN B1a, B2a, B1ci, B1cii, B1civ, B2ci, B2cii, B2civ
- is likely to have suffered extreme fluctuations "projected or inferred" in the extent of occurrence, area of occupancy and the number of mature individuals based on the permanent loss of likely surrounding habitat to wheat paddocks = IUCN C, C2ai, C2aii and D

Based on satisfying IUCN criteria A, A2, A4, B1, B2, B1a, B2a, B1ci, B1cii, B1civ, B2ci, B2cii, B2civ, C, C2ai, C2aii and D, *Eremophila crassifolia* is critically endangered in New South Wales and eligible for listing under the NSW *Threatened Species Conservation Act*.

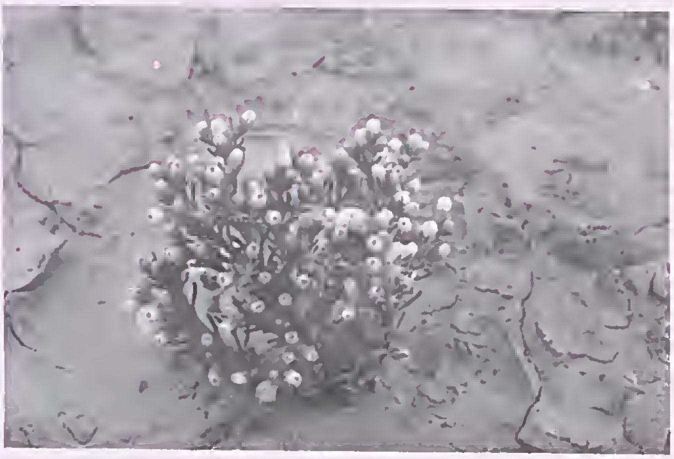

Fig. 6. *Elachanthus glaber* growing on a copi or gypseous rise at Nanya Station 135 km north-north-west of Wentworth, in southwest New South Wales in August 2010. Photograph Ian Sluiter 23/08/2010.

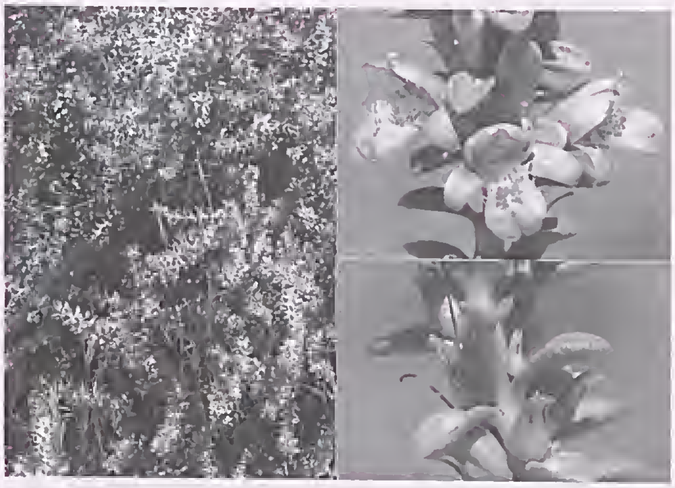

Fig. 7. *Eremophila crassifolia* showing the whole plant, flowers and leaves. Photograph Copyright © Paul Gullan/Viridans Images.

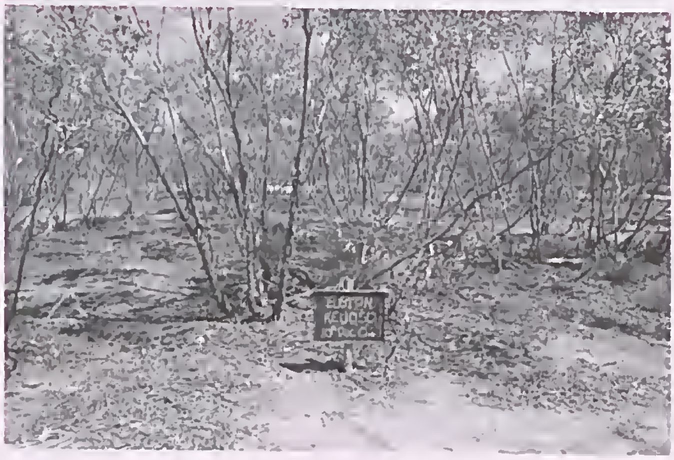

Fig. 8. Habitat of *Eremophila crassifolia* northeast of Trentham Cliffs at the author's site KEU050 (internal database code). Photograph Ian Sluiter 10/12/2004

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The Eucalypts of the Greater Blue Mountains World Heritage Area: distribution, classification and habitats of the species of *Eucalyptus, Angophora* and *Corymbia* (family Myrtaceae) recorded in its eight conservation reserves

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Abstract: The Greater Blue Mountains World Heritage Area (GBMWHA), immediately west of Sydney (33° 53'S; 151° 13'E), on the east coast of Australia was listed as World Heritage for its outstanding natural values, a major component of which is the high number of eucalypt species and eucalypt-dominated communities present, some 13 per cent of all eucalypt species in the world. They grow in a great variety of plant communities, from tall closed forests, through open forests and woodlands, to stunted mallee shrublands.

This paper provides a definitive list of the 96 eucalypts (species of the genera *Eucalyptus, Angophora* and *Corymbia* in the family Myrtaceae), that have been recorded there (55 widespread, 41 restricted), together with the distribution of the eucalypts in the eight reserves that make up the GBMWHA, and information on the classification and habitat of the different species. The information is based on records held at the National Herbarium of New South Wales and the results of surveys by the NSW Department of Environment, Climate Change and Water (DECCW) over the past 20 years. The majority of species have components of both stress-tolerator and competitor ecological strategies and this has probably been a main contributor to their success. However details of the ecology of the majority of taxa are poorly-known and more research is needed to provide guidance for conservation management in the face of changing climate conditions.

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Introduction

The Greater Blue Mountains World Heritage Area (GBMWHA) immediately west of Sydney (33° 53'S; 151° 13'E), on the east coast of Australia, was inscribed on the World Heritage list in 2000. It covers over one million hectares (1 032 649 ha) and covers eight protected conservation reserves, largely contiguous but partly separated by transport and urban corridors. There are seven national parks as well as the Jenolan Caves Karst Conservation Reserve (2 422 ha). The National Parks are Blue Mountains (247 840 ha in area), Wollemi (499 879 ha), Yengo (153 483 ha), Nattai (47 855 ha), Kanangra-Boyd (65 379 ha), Gardens of Stone (15 150 ha) and Thirlmere Lakes (641 ha) (Figure 1). Approximately 60% of the area is dedicated as wilderness (669 000 ha).

The GBMWHA was listed for its outstanding natural universal values:

- As an outstanding example representing significant ongoing ecological and biological processes in the evolution of terrestrial ecosystems and communities of plants and animals; and
- For containing the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

It is not just because of its magnificent scenery, or the distant blue haze that sometimes appears over the rugged landscape. It is the eucalypt forests, more than anything else, that make the area special. The Blue Mountains have been described as a natural laboratory for the study of evolution of eucalypts. In the mountains' diverse plant communities, you can trace the changing nature of the Australian environment – from geological shifts and climate variations, through to the impact of Aboriginal settlement and European colonisation.

The aim of this paper is to provide a definitive list of the GBMWHA eucalypts (species of the genera *Eucalyptus, Angophora* and *Corymbia* in the family Myrtaceae), together with information on their distribution, classification and habitat which will provide a basis for further research and to assist communication of the important biodiversity values of the area.

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Eucalypts in Australia

The eucalypts or gum trees are a characteristic Australian group of species (mainly trees but with some small shrublike mallees) belonging in the Myrtaceae family (for ecology of Myrtaceae in the Sydney area – see Myerscough 1998). More than 98% of the 700 or so known eucalypt species are endemic to Australia. Most eucalypts are in the genus *Eucalyptus* but the similarly-looking and closely-related genera *Angophora* and *Corymbia* are also traditionally included as eucalypts in general usage. *Eucalyptus* itself is considered to include two large subgenera, *Eucalyptus (Monocalyptus)* and *Symphyomyrtus*, and a number of smaller ones (notably *Eudesmia* in northern Australia)

As well as the bud and fruit characteristics which are generally needed for positive identification, a distinctive characteristic of the group is the nature of the bark. Bark types which give their names to broad groups include stringybarks, ironbarks, boxes, bloodwoods, peppermints as well as smooth-barked gums. These bark types are the basis for many of the common names applied to the species though unfortunately they do not necessarily align with the generic or subgeneric groups. Smooth-barked gums for example occurring in most of the major groups e.g. *Angophora costata*, *Corymbia maculata*, *Eucalyptus tereticornis*.

Eucalypts originated between 35 and 50 million years ago, not long after Australia-New Guinea separated from Gondwana, their rise coinciding with an increase in fossil charcoal deposits (suggesting that fire was a factor even then). However, they remained a minor component of the Tertiary rainforest until about 20 million years ago when the gradual drying of the continent and depletion of soil nutrients led to the development of more open forest types, predominantly *Casuarina* and *Acacia* species. Major redistributions of eucalypt forest occurred in southeastern Australia during the Quaternary, probably in relation to both temperature and aridity changes. According to McKinnon et al (2004), patterns of morphological variation within *Eucalyptus* in Tasmania, in particular intergradation between species, suggest that these redistributions might have enabled divergent species to come into contact and exchange genes through hybridization (reticulate evolution). Similar processes probably occurred in the GBMWHA leading to closely-related groups of species such as the *Eucalyptus*–Green-leaved Ashes.

The Eucalypts of the Greater Blue Mountains World Heritage Area

A list of eucalypt species present was included in the GBMWHA nomination in 1998 (Appendix 6.2 in NPWS 1998). This list has now been updated to include newly described species and delete unconfirmed species, and enlarged to provide species occurrence in the individual reserves of the GBMWHA with data from specimen records held at the National Herbarium of New South Wales, together

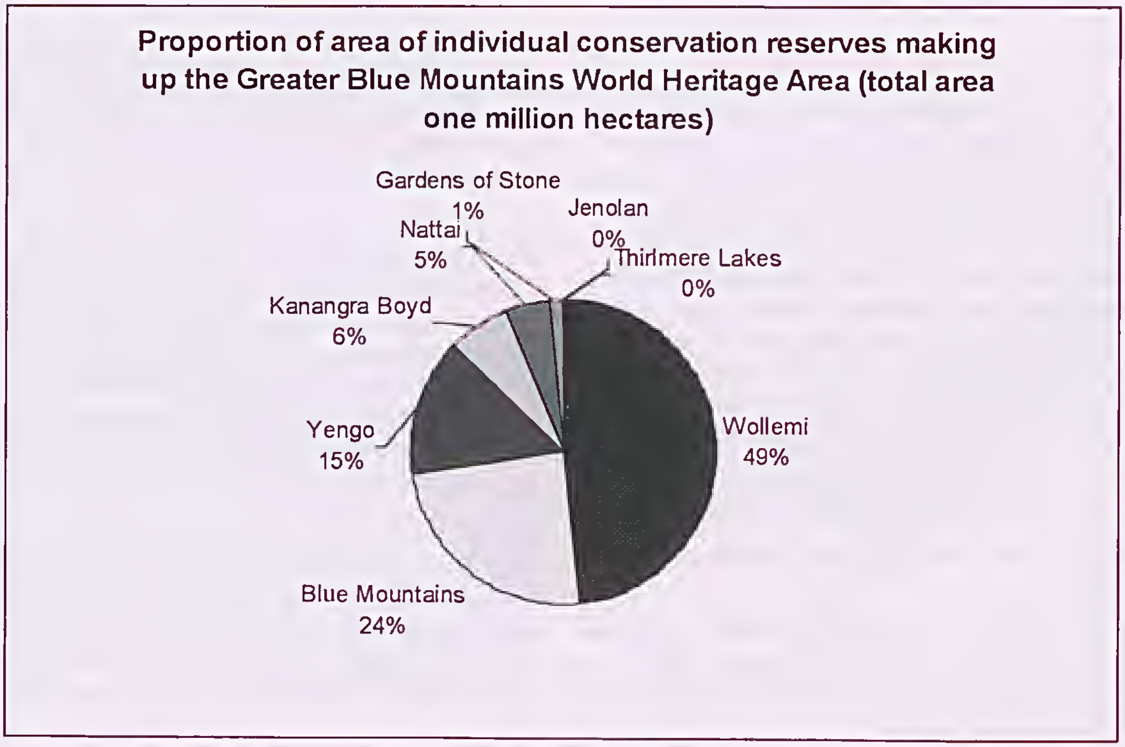

Fig. 1. Proportion of area of individual conservation reserves making up the Greater Blue Mountains World Heritage Area (total area one million hectares)

Table 1a. Eucalypt species with relatively widespread distributions in the Greater Blue Mountains World Heritage Area showing occurrence in conservation reserves.
Based on records from the National Herbarium of New South Wales and surveys by the NSW Dept of Environment, Climate Change and Water.

National Parks	**Wollemi**	**Yengo**	**Gard. of Stone**	**Blue Mtns**	**Jenolan Karst Cons Res**	**Kanang. Boyd**	**Thirl. Lakes**	**Nattai**
Reserve size (ha)	499879	153483	15150	247840	2422 ha	65379	641	47855
Eucalypt species								
Angophora bakeri	W	Y		B			T	N
Angophora costata	W	Y		B				N
Angophora floribunda	W	Y	G	B		K	T	N
Corymbia eximia	W	Y		B			T	
Corymbia gummifera	W	Y		B		K	T	N
Eucalyptus agglomerata	W	Y		B		K	T	N
Eucalyptus albens	W		G	B				N
Eucalyptus amplifolia subsp. amplifolia	W	Y		B				
Eucalyptus bicostata	W			B	J			
Eucalyptus blakelyi	W		G	B				
Eucalyptus blaxlandii	W		G	B	J	K		N
Eucalyptus bosistoana				B		K		N
Eucalyptus bridgesiana	W			B				
Eucalyptus consideniana	W			B				
Eucalyptus crebra	W	Y	G	B		K		N
Eucalyptus cypellocarpa	W		G	B	J	K		N
Eucalyptus dalrympleana subsp. *dalrympleana*	W		G	B	J	K		
Eucalyptus deanei	W	Y		B		K		N
Eucalyptus dives	W		G	B	J	K		
Eucalyptus elata				B		K		N
Eucalyptus eugenioides	W	Y	G	B	J	K		N
Eucalyptus fastigata	W		G	B	J	K		
Eucalyptus fibrosa	W	Y	G	B		K		N
Eucalyptus globoidea	W			B				N
Eucalyptus macrorhyncha	W		G	B				
Eucalyptus mannifera subsp. *gullickii*	W		G	B		K		
Eucalyptus mannifera subsp. *mannifera*			G	B		K		
Eucalyptus melliodora	W	Y	G	B	J	K		N
Eucalyptus moluccana	W	Y	G	B				N
Eucalyptus multicaulis	W		G	B				
Eucalyptus notabilis		Y		B				
Eucalyptus obliqua				B		K		
Eucalyptus oreades	W		G	B				N
Eucalyptus ovata				B		K		N
Eucalyptus paniculata subsp. *paniculata*	W	Y		B				
Eucalyptus parramattensis subsp. *parramattensis*	W	Y	G				T	N
Eucalyptus pauciflora				B	J	K		
Eucalyptus pilularis		Y		B				
Eucalyptus piperita	W	Y	G	B		K	T	N
Eucalyptus polyanthemos subsp. polyanthemos	W		G					
Eucalyptus praecox	W		G					
Eucalyptus punctata	W	Y	G	B	J	K	T	N
Eucalyptus radiata subsp. *radiata*	W		G	B	J	K		N
Eucalyptus resinifera subsp. *resinifera*	W			B			T	
Eucalyptus rossii	W		G	B				
Eucalyptus saligna	W	Y						
Eucalyptus sclerophylla	W	Y	G	B		K		N
Eucalyptus sideroxylon	W			B		K		N
Eucalyptus sieberi	W		G	B	J	K	T	N
Eucalyptus smithii				B		K		
Eucalyptus sparsifolia	W	Y	G	B	J	K		N
Eucalyptus stricta	W			B		K		
Eucalyptus tenella	W		G					
Eucalyptus tereticornis	W	Y	G	B		K		N
Eucalyptus viminalis	W		G	B	J	K		N

Table 1b. Eucalypt species with relatively restricted distributions in the Greater Blue Mountains World Heritage Area showing occurrence in conservation reserves, comments on the overall distribution, and formal and informal conservation listings. Conservation listings TSC=NSW *TSC* Act, EPBC=Commonwealth *EPBC* Act; *=IUCN (proposed by Bell 2008). Notes on overall distribution are from PlantNet and Fairley and Moore (2000).

Eucalypt species	GBMWHA reserves	Why uncommon in the GBMWHA	Cons. listing-statutory	Cons. listing ROTAP, IUCN
Angophora euryphylla	Yengo, Wollemi	Restricted distribution – sandstone outcrops between the Central Coast and Putty.		
Angophora hispida	Yengo, Wollemi	Widespread on shallow soils on Hawkesbury sandstone plateaus near the coast. Uncommon in the GBMWHA.		
Corymbia maculata	Wollemi	Widespread on moderately fertile soils on drier parts of the coastal plain and escarpment from Queensland to Victoria. Its preferred combination of soil fertility and climate is limited in the GBMWHA.		
Corymbia trachyphloia subsp. *amphistomatica*	Wollemi	Widespread along the western slopes north from Denman. Suitable climatic conditions only occur in the far north of the GBMWHA.		
Eucalyptus aenea	Wollemi	Restricted distribution – sandstone ridges around northern Wollemi NP, Goulburn River NP and Manobolai NR		2RC-, VU D2*
Eucalyptus aggregata	Blue Mtns	Occurs on cold alluvial flats from Wallerawang to Victoria. Suitable climatic and drainage conditions are limited in the GBMWHA.	Vulnerable (TSC)	
Eucalyptus apiculata	Blue Mtns, Nattai	Restricted distribution – scattered populations on skeletal soils between Linden and Berrima		3RC
Eucalyptus baeuerlenii	Blue Mtns	Restricted distribution – scattered populations at Wentworth Falls, Budawang Range, Wadbilliga NP.		3RCa
Eucalyptus baueriana	Wollemi	Alluvial soils along streams from Putty south to Victoria. Suitable fertile alluvial soils are limited within the GBMWHA.		
Eucalyptus bensonii	Wollemi	A species endemic to the GBMWHA, only found on the Wollemi and Hunter Ranges.		2RCa VU D2*
Eucalyptus benthamii	Blue Mtns, Nattai	Restricted distribution – alluvial soils in the lower Hawkesbury-Nepean catchment	Vulnerable (TSC) Vulnerable (EPBC)	2VCi
Eucalyptus beyeriana	Wollemi	Locally frequent in drier areas between Narrabri and Nowra. Suitable soil and climatic conditions are limited in the GBMWHA.		
Eucalyptus burgessiana	Wollemi, Blue Mtns, Nattai	A species endemic to the GBMWHA, with scattered populations on skeletal soils at lower elevations.		2RCa VU D2 *
Eucalyptus caleyi subsp. *caleyi*	Wollemi	Widespread along the western slopes north from about the Goulburn River into Queensland. Suitable climatic conditions only occur in the far north of the GBMWHA.		
Eucalyptus camphora subsp. *camphora*	Wollemi, Blue Mtns	On open swampy flats from Nullo Mountain to the Megalong Valley. Suitable swampy alluvial soils are limited within the GBMWHA.		
Eucalyptus cannonii	Wollemi, Gardens of Stone	Restricted distribution – Bylong to the upper Wolgan Valley on moderately fertile soils. Suitably fertile soils within its limited distribution are uncommon in the GBMWHA.	Vulnerable (TSC) Vulnerable (EPBC)	2RCa LC *
Eucalyptus capitellata	Yengo	Locally frequent on sandy soils on coastal foothills between Karuah and Nerriga. Uncommon in the GBMWHA.		
Eucalyptus conica	Wollemi	Widespread along the western slopes from Wagga Wagga to Queensland. Its preferred combination of a dry climate and fertile soils only occurs in very limited parts of northern Wollemi.		
Eucalyptus corticosa	Wollemi	Restricted distribution – upper Cudgegong River on sandstone ridges.	Vulnerable (TSC)	2VC-VU D2 *
Eucalyptus cunninghamii	Blue Mtns, Kanangra Boyd, Nattai	A species endemic to the GBMWHA, with localised populations on skeletal soils in the upper Blue Mountains and Wanganderry Tableland.		2RCa

Eucalyptus dawsonii	Wollemi	Locally frequent on the western slopes and Hunter valley between Wellington and Singleton. The suitable combination of climate and soil fertility only occurs on escarpment footslopes in northern Wollemi.	Vulnerable Ecological Community (TSC)	
Eucalyptus dendromorpha	Blue Mtns	Restricted distribution – scattered populations from Mt Tomah to the Budawang Range.		
Eucalyptus dwyeri	Wollemi	Widespread on shallow soils along the western slopes from Victoria to Queensland. Suitable climatic conditions only occur in the far north of the GBMWHA.		
Eucalyptus fergusonii subsp. *dorsiventralis*	Yengo, Wollemi	Restricted distribution – Lake Macquarie and northern Yengo NP to Mountain Lagoon		3RCa LC *
Eucalyptus fracta	Yengo	Restricted distribution – sandstone ranges between the Hunter valley and northern Yengo NP	Vulnerable (TSC)	2V
Eucalyptus hypostomatica	Yengo, Wollemi, Blue Mtns, Nattai	Localised distribution – the lower Hunter Valley to Kangaroo Valley		3RC- LC *
Eucalyptus laevopinea	Wollemi	Widespread on the tablelands from Mt Coricudgy to Queensland. A species typical of the Northern Tablelands with a disjunct population south of the Hunter valley		
Eucalyptus laophila	Wollemi, Gardens of Stone	Restricted distribution – skeletal soils from Newnes Plateau to Nullo Mountain		
Eucalyptus ligustrina	Gardens of Stone, Blue Mtns	Disjunct populations on sandy soils between the Gibraltar Range and Deua NP		
Eucalyptus macarthurii	Kanangra Boyd	Restricted distribution – cold flats on the Southern Highlands, with an outlying occurrence on the Boyd Plateau	Vulnerable (TSC)	
Eucalyptus michaeliana	Yengo	Highly disjunct distribution – Broke to St Albans, Enmore to Wollomombi and in Queensland.		3RCa
Eucalyptus moorei	Blue Mtns, Kanangra Boyd	Disjunct occurrences on sandy soils in the Gibraltar Range, Blue Mountains & the Budawang Range		
Eucalyptus muelleriana	Blue Mtns	Widespread along the coast and escarpment from Bindook Highlands to Victoria. It reaches its northern limit in the GBMWHA.		
Eucalyptus nubila	Wollemi, Gardens of Stone	On sandy soils along the western slopes north from about Capertee to Queensland. Suitable climatic and soil conditions are limited within the GBMWHA.		
Eucalyptus prominula	Yengo, Wollemi	Restricted distribution – skeletal soils from the Watagans to Colo Heights		2RC- LC *
Eucalyptus quadrangulata	Blue Mtns, Kanangra Boyd	Disjunct occurrences along the escarpment – Bundanoon to the Bindook Highlands, Barrington Tops to Dorrigo		
Eucalyptus ralla	Blue Mtns	Restricted distribution – sandstone soils from Lake Burragorang to Yalwal Plateau		
Eucalyptus rubida subsp. *rubida*	Kanangra Boyd	Widespread on cold flats south from Sofala to Victoria. Sufficiently cold conditions are limited in the GBMWHA.		
Eucalyptus scias subsp. scias	Wollemi	Central Coast to northern Sydney, Colo Heights area: mainly occurs on hilly parts of the coastal plain, uncommon in the GBMWHA.		
Eucalyptus squamosa	Yengo, Wollemi	On sandstone from Cessnock to near Picton. Uncommon in the GBMWHA because it mainly occurs on plateaus nearer the coast.		
Eucalyptus stellulata	Blue Mtns. Kanangra Boyd	Widespread on cold flats at higher altitudes from the McPherson Range to Victoria. Sufficiently cold conditions are rare in the GBMWHA.		
Potential additional species				
Eucalyptus copulans	Not recorded in GBMWHA reserves	Highly localised at Wentworth Falls (but only recorded just outside the GBMWHA reserve boundary)	Endangered (TSC)	2E
Eucalyptus expressa ms. (also known as *Eucalyptus* sp. aff. *eugenioides* (Bees Nest Ridge)	Yengo, Wollemi	Restricted distribution – sheltered gullies in northern Wollemi and Yengo. Awaiting formal description before inclusion in the GBMWHA list.		3KC DD *
Eucalyptus gregsoniana	Not recorded in GBMWHA reserves	Sporadic and scattered, in mallee heath on sandy soils of limited drainage in elevated areas; Wadhilliga to Newnes Plateau (on margin of GBMWHA).		3RCa
Eucalyptus sp. Howes Swamp Creek (Doherty 26)	Wollemi	Awaiting formal description before inclusion in the GBMWHA list.	Endangered (TSC) Endangered (EPBC)	2ECi CR D1*
Eucalyptus nobilis	Wollemi	Reported near Mount Coricudgy (Stephen Bell pers. com. 2010). Still to be confirmed.		

with records of recent surveys by the New South Wales Department of Environment, Climate Change and Water (DECCW) and its predecessors over the past 20 years. Since the inscription of the GBMWHA in 2000, vegetation surveys have been undertaken in the Jenolan Karst Conservation Reserve, Nattai, Thirlmere Lakes, Yengo, Gardens of Stone and much of Blue Mountains National Park. The survey of Wollemi NP is currently in progress, and surveys are in the planning stage for Kanangra Boyd NP and the Grose Valley. A number of eucalypts not known from the GBMWHA at the time of its inscription have now been confirmed. Nomenclature and authorities follow PlantNet, the website for the National Herbarium of NSW. (Note: the term species (rather than taxa) is used in this paper in the broadest sense and includes subspecific taxa).

98 recognised eucalypt taxa (mostly species of *Eucalyptus* but including five *Angophora* and four *Corymbia* species) have been recorded in the eight reserves of the GBMWHA (Tables 1a and 1b). The species range in size from large forest trees over 30 m in height (e.g. *Eucalyptus deanei*, *Eucalyptus saligna*), through spreading woodland trees (e.g. *Eucalyptus sclerophylla*) to small multistemmed mallees, some less than 1 m in height in heathland (*Eucalyptus cunninghamii*). More than half of the species (58) (Table 1a) are regarded as widespread in the GBMWHA i.e. recorded from two or more reserves (e.g. *Eucalyptus punctata*), but others recorded from only one reserve (42 species) (Table 1b) (e.g. *Eucalyptus baeuerlenii)*, may be relatively to very restricted, although the great disparity in size of the reserves (Figure 1) makes this a very rough measure. The restricted eucalypts are either widespread species with habitat requirements that are of limited extent within the GBMWHA or species that have a naturally restricted distribution. The former are usually more typical of drier, colder or more coastal environments.

Clarification of the list of eucalypts in the original GBMWHA nomination

90 eucalypts were included in the List of Eucalypts in the GBMWHA nomination (Appendix 6.2 in NPWS 1998). However, two of those (*Eucalyptus siderophloia* & *Eucalyptus umbra*) have not been subsequently confirmed as occurring within the GBMWHA. *Eucalyptus siderophloia* is found on moderately fertile soils on the coastal plain but the nearest records to the GBMWHA are east of Yengo National Park. *Eucalyptus umbra* has also been recorded near Yengo National Park. While records for both species are close to Yengo NP, no confirmed GBMWHA records have been found.

Eucalyptus rudderi was included in the nomination because it was formerly considered to occur from Taree to near the Shoalhaven River (eg Brooker & Kleinig 1983). Johnson and Hill (1990) separated *Eucalyptus hypostomatica* from *Eucalyptus rudderi* on the basis of the former's broad-lanceolate to ovate, hypostomatic adult leaves. This meant that *Eucalyptus rudderi* is now confined to the Taree-Karuah district on the mid north coast of NSW. Hence, *Eucalyptus rudderi* has been replaced by *Eucalyptus hypostomatica* in the current list.

The original nomination included an undescribed taxon, *Eucalyptus* sp. aff. *dalrympleana*, which has not been included in the current list because there is insufficient information to attribute it to any newly described or undescribed species.

Subspecies names were not attributed to *Eucalyptus radiata* and *Eucalyptus mannifera* in the nomination. We have listed *Eucalyptus radiata* subsp. *radiata* as it is the only subspecies occurring in the GBMWHA. The reference to *Eucalyptus mannifera* could have been to either of *Eucalyptus mannifera* subsp. *gullickii* or *Eucalyptus mannifera* subsp. *mannifera*. However, it was probably the former because this taxon is more widespread in the Blue Mountains.

The current list remains subject to change as further survey and exploration bring to light new occurrences of species, and perhaps even new species. Bell (2008) in his list of rare or threatened plants of Wollemi NP, includes two species that were not formally described at that time. *Eucalyptus* sp aff. *eugenioides* (Bees Nest Ridge) is a stringybark found in sheltered gullies in northern Wollemi and Yengo NPs (to be named *Eucalyptus expressa* – Bell, Klaphake & Nicolle, in prep). *Eucalyptus* sp. Howes Swamp Creek (Doherty 26) is only known from one small stand growing on alluvium in the Mellong Swamps (and is listed as Endangered under the *EPBC* and *TSC* Acts). As neither taxon has been formally described (2010) they are included in Table 1b as *potential additional species*.

A small population of mallee-like red gums currently attributed to *Eucalyptus dealbata* has been recorded near the Martindale Trail in northern Wollemi NP (Bell 2001). Confirmation of the identity of these specimens is required because this population would represent a considerable range extension and it occurs on infertile soils on Narrabeen Sandstone, which is an unusual substrate for this species. This taxon has not been included in Table 1b.

Further change is also likely to result from ongoing systematic and ecological research into the relationships between species. For example recent work on the scribbly gum group (Pfeil & Henwood 2004) indicates that this group is best treated as 3 taxa rather than the current 5. If accepted and applied to the GBMWHA list this would probably mean replacing *Eucalyptus racemosa*, *Eucalyptus rossii* and *Eucalyptus sclerophylla* with *Eucalyptus racemosa* subsp. *racemosa* and *Eucalyptus racemosa* subsp. *rossii*.

Rare or threatened species

Two thirds of the species have a number of populations in at least two of the eight GBMWHA reserves indicating many species are relatively widespread and well-conserved in the region (Table 1a).

Of those limited to one national park (Table 1b), some are at the edge of a much wider distribution beyond the GBMWHA. (e.g. *Eucalyptus dwyeri*, *Eucalyptus muelleriana*). Others are very restricted. Some such as *Eucalyptus bensonii*, *Eucalyptus baeuerlenii*, and *Eucalyptus laophila* are very restricted but have most or all of their distribution protected within the GBMWHA. Others (e.g. *Eucalyptus hypostomatica, Eucalyptus michaeliana)* have reasonably large populations within the GBMWHA. Six of the rare eucalypts are mallees with three being endemic to the GBMWHA (*Eucalyptus bensonii. Eucalyptus burgessiana. Eucalyptus cunninghamii).*

Other restricted species are less well protected. Six are listed as vulnerable under the NSW *Threatened Species Conservation* Act (TSC Act) a low proportion (6%) compared with listings for other parts of NSW as the extensive area of the GBMWHA has provided conservation security for most species. Two of these species are also listed as Vulnerable under the Commonwealth *Environment Protection and Biodiversity Conservation* (EPBC) Act. Due to their small population sizes, the primary threat to *Eucalyptus fracta* and *Eucalyptus corticosa* are risks from chance stochastic events. *Eucalyptus aggregata*, *Eucalyptus cannonii* and *Eucalyptus macarthurii* primarily occur on agricultural lands with modified pastures. They are threatened by lack of regeneration and are poorly represented in conservation reserves. *Eucalyptus benthamii* is threatened by increased nutrients, frequent burning and weed invasion in its habitat of alluvial flats. Much of its habitat has been cleared for agriculture or submerged beneath the waters of Lake Burragorang (Benson 1985).

Eucalyptus dawsonii is a community dominant in the Vulnerable Ecological Community *Hunter Valley Footslopes Slaty Gum Woodland in the Sydney Basin Bioregion* that occurs below the escarpment in northern Wollemi NP near Jerrys Plains. This community is threatened by clearing, emerging weeds and frequent burning (Peake 2006).

A further ten eucalypts have been recognised as rare on the list of Rare or Threatened Australian Plants (ROTAP, Briggs & Leigh 1996).). These eucalypts typically have a highly restricted or disjunct distribution, but are subject to a lower level of threat. A good example is *Eucalyptus baeuerlenii*, which has a very restricted distribution on cliff ledges at Wentworth Falls–Leura, but is within the GBMWHA and is being managed for conservation.

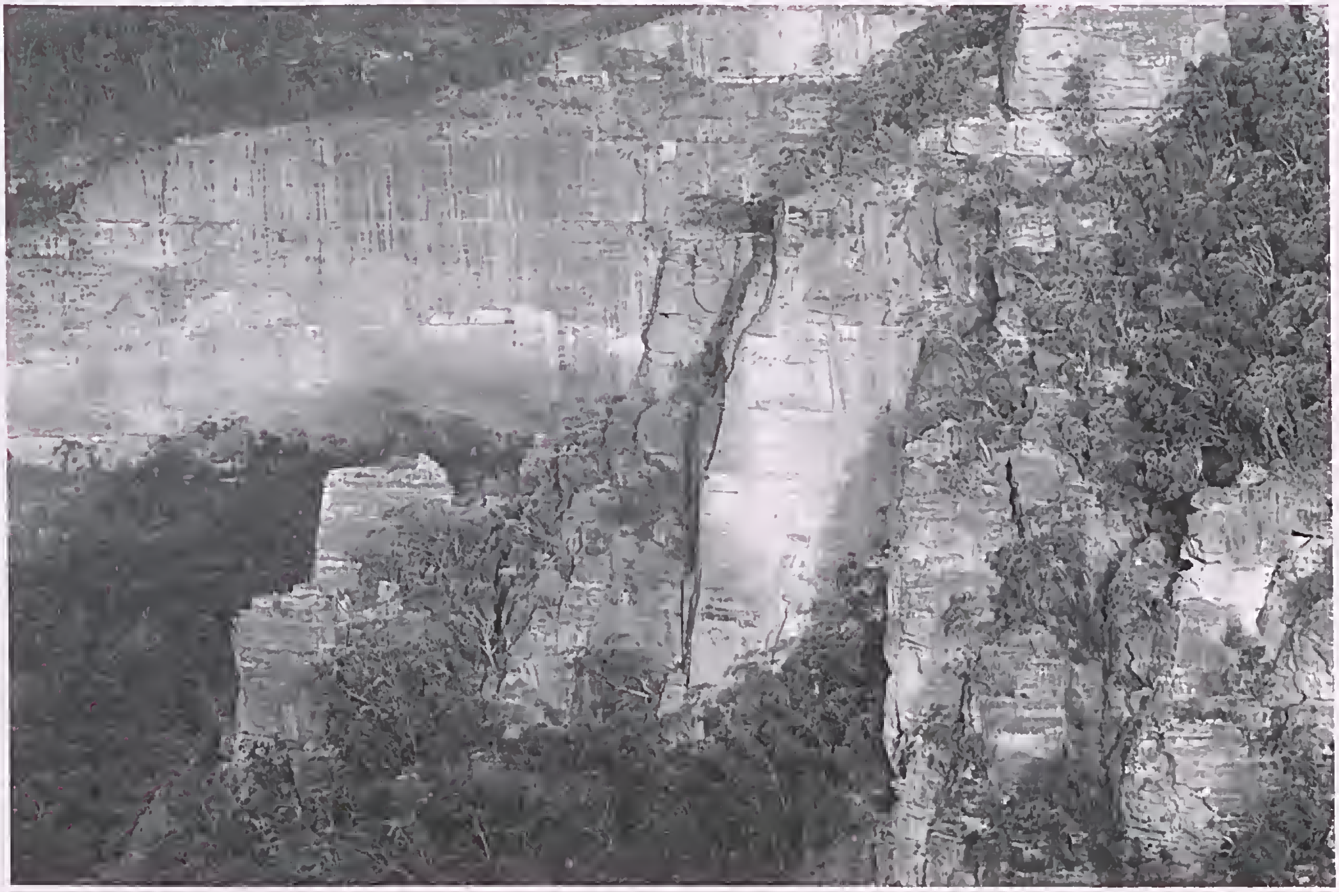

Fig. 2. Many eucalypt species grow in the dissected sandstone landscapes of the Blue Mountains and Wollemi areas where habitats range from moist sheltered gullies to exposed ridges and clifflines.

Table 2. Classification of eucalypts of the Greater Blue Mountains World Heritage Area showing subgeneric groups and lower groups in Eucalyptus (after Hill 2002) with provisional notes on generalised group ecology.

Genus		**Generalised group ecology**
Angophora		
	Angophora costata	Large or small trees on range of soils and rainfall, flower Summer, seeds shed at maturity, prolific seedling recruitment
	Angophora floribunda	
	Angophora euryphylla	
	Angophora bakeri	
	Angophora hispida	
Corymbia		
	Corymbia maculata	Trees on range of soils and rainfall, mature seeds retained on tree
	Corymbia gummifera	
	Corymbia eximia	
	Corymbia trachyphloia subsp. *amphistomatica*	
Eucalyptus	***Symphyomyrtus* – Adnataria**	
	Eucalyptus aenea	Mostly woodland or forest trees, mostly Ironbarks or boxes; generally lower rainfall areas, medium nutrient soils clays or clay-influenced sandstones; Flower Winter–Spring, seed shed at maturity; recruitment respond to seasonal conditions; long-lived, slow-growing
	Eucalyptus albens	
	Eucalyptus baueriana	
	Eucalyptus beyeriana	
	Eucalyptus bosistoana	
	Eucalyptus caleyi subsp. *caleyi*	
	Eucalyptus crebra	
	Eucalyptus dawsonii	
	Eucalyptus fergusonii subsp. *dorsiventralis*	
	Eucalyptus fibrosa	
	Eucalyptus hypostomatica	
	Eucalyptus melliodora	
	Eucalyptus moluccana	
	Eucalyptus nubila	
	Eucalyptus paniculata subsp. *paniculata*	
	Eucalyptus sideroxylon	
	Eucalyptus conica	
	Eucalyptus fracta	
	Eucalyptus polyanthemos subsp. *polyanthemos*	
Eucalyptus	***Symphyomyrtus* – Bisectaria**	
	Eucalyptus squamosa	Tree or mallee on low nutrient soil, flowers Winter, seed retained for up to a year. Only GBMWHA representative of a group of mainly Western Australian mallees.
Eucalyptus	***Symphyomyrtus* – Exsertaria**	
	Eucalyptus amplifolia subsp. *amplifolia*	'Redgum' group; Trees on a range of soil and rainfall conditions; flower Spring or Summer, seed retained for up to a year, recruitment episodic, quick growing
	Eucalyptus blakelyi	
	Eucalyptus dwyeri	
	Eucalyptus michaeliana	
	Eucalyptus parramattensis subsp. *parramattensis*	
	Eucalyptus tereticornis	
Eucalyptus	***Symphyomyrtus* – Maidenaria**	
	Eucalyptus aggregata	'Mountain Gums' on medium or low–medium nutrient soils, often montane or cooler Tablelands sites, often with higher rainfall, riparian or periodic swamp requirements; Flowering in all seasons depending on individual species, seeds retained for a year or shed at maturity depending on season. Fire response species-specific, some strongly epicormic, others weakly epicormic and relatively fire-sensitive.
	Eucalyptus baeuerlenii	
	Eucalyptus benthamii	
	Eucalyptus bicostata	
	Eucalyptus bridgesiana	
	Eucalyptus camphora subsp. *camphora*	
	Eucalyptus cypellocarpa	
	Eucalyptus dalrympleana subsp. *dalrympleana*	
	Eucalyptus mannifera subsp. *gullickii*	
	Eucalyptus mannifera subsp. mannifera	
	Eucalyptus ovata	
	Eucalyptus quadrangulata	
	Eucalyptus rubida subsp. *rubida*	
	Eucalyptus smithii	
	Eucalyptus viminalis	
	Eucalyptus macarthurii	
	Eucalyptus praecox	
	Eucalyptus corticosa	

Genus	–	Generalised group ecology
Eucalyptus	***Symphyomyrtus*** **– Transversaria** *Eucalyptus deanei* *Eucalyptus notabilis* *Eucalyptus punctata* *Eucalyptus resinifera* subsp. *resinifera* *Eucalyptus scias* subsp. *scias* *Eucalyptus saligna*	'Coastal Blue Gums' , quick-growing forest trees,on medium – high nutrient soils, coastal, low elevation sites; mostly Summer flowering with mature seeds shed sporadically after the next Summer. Generally vigorous seedling recruitment.
Eucalyptus	***Eucalyptus*** **– Blue-leaved ashes A** *Eucalyptus oreades* *Eucalyptus pauciflora* *Eucalyptus piperita*	Woodland or forest trees, often community dominants, on low – high nutrient soils, flowering Summer, seeds retained in capsules for up to a year, fire response variable, strong epicormic or resprouting to killed (*E. oreades*). Seedling recruitment vigorous, not fire dependent, often colonisers of disturbed sites.
Eucalyptus	***Eucalyptus*** **– Blue-leaved ashes B** *Eucalyptus consideniana* *Eucalyptus multicaulis* *Eucalyptus rossii* *Eucalyptus sclerophylla* *Eucalyptus sieberi*	Mainly woodland trees, often community dominants, on low nutrient soils; flowering Spring/Summer, seeds retained in capsules for up to a year; fire response strong epicormic or lignotuberous resprouting. Seedling recruitment sporadic.
Eucalyptus	***Eucalyptus*** **– Black sallies** *Eucalyptus moorei* *Eucalyptus stellulata*	Mallees or small trees, low to medium nutrient soils at high elevation, flowering Autumn
Eucalyptus	***Eucalyptus*** **– Green-leaved ashes** *Eucalyptus apiculata* *Eucalyptus burgessiana* *Eucalyptus cunninghamii* *Eucalyptus dendromorpha* *Eucalyptus fastigata* *Eucalyptus laophila* *Eucalyptus obliqua* *Eucalyptus stricta*	Mainly long-lived mallees, on low-nutrient sandy soils, flowering Summer, with seed retained in capsules for about a year, vigorous lignotuberous regrowth after fire, seedlings rarely reported. *Eucalyptus fastigata*, large tree on high nutrient soils is exception.
Eucalyptus	***Eucalyptus*** **– Peppermints** *Eucalyptus dives* *Eucalyptus elata* *Eucalyptus pilularis* *Eucalyptus radiata* subsp. *radiata*	Trees, on range of soils, flower Spring, seeds shed or retained, juvenile recruitment generally conspicuous, fire response strong to weak epicormic growth
Eucalyptus	***Eucalyptus*** **– Stringybarks** *Eucalyptus agglomerata* *Eucalyptus bensonii* *Eucalyptus blaxlandii* *Eucalyptus cannonii* *Eucalyptus capitellata* *Eucalyptus eugenioides* *Eucalyptus globoidea* *Eucalyptus laevopinea* *Eucalyptus ligustrina* *Eucalyptus macrorhyncha* *Eucalyptus muelleriana* *Eucalyptus prominula* *Eucalyptus ralla* *Eucalyptus sparsifolia* *Eucalyptus tenella*	A large group of trees, small trees and mallees often with populations intergrading with nearby stringybark species; mostly on low nutrient soils, but some on medium and high nutrient soils, over a wide range of rainfall, though all in well-drained sites. Flower mainly Autumn–Winter, sporadically. Seed retained for up to a year, seedling recruitment sporadic.

Significant species just outside the GBMWHA

An endangered species *Eucalyptus copulans* now persists as only two individuals in suburban Wentworth Falls within a kilometre of the boundary of the GBMWHA. Because of the clearing for urban development it is now too late to determine its original distribution, but it was evidently very restricted and indicates the vulnerability to human impacts of species with very restricted occurrences.

Eucalyptus gregsoniana which has a ROTAP code of 3RCa occurs on Newnes Plateau in close proximity to the GBMWHA. It typically occurs above 1100m elevation and may be present in the higher parts of the catchments of the Wollangambe River, the Wolgan River or Carne Creek.

Classification of GBMWHA eucalypt species

The genus *Eucalyptus* was described in 1792 from specimens of *Eucalyptus obliqua* from Tasmania. However specimens of *Angophora costata* and *Corymbia gummifera* were collected by Joseph Banks and Daniel Solander at Botany Bay in 1770 and named by Joseph Gaertner in 1788 as *Metrosideros costata* and *Metrosideros gummifera* respectively. The first eucalypt collections from the GBMWHA were probably made by the botanist George Caley who explored Thirlmere Lakes in 1802 and the lower Blue Mountains reaching as far as Mount Banks in 1804.

Description of the 700 or so eucalypts has involved many prominent Australian botanists including Ferdinand Mueller, Joseph Maiden and William Blakely. In 1971 Pryor and Johnson (1971) proposed a classification dividing the group into a number of subgenera; subsequent research has supported the various subgeneric groupings, but raised questions over their relative ranks. For the eucalypts of the GBMWHA three genera are currently recognised, *Angophora*, *Corymbia* (raised to generic rank by Hill & Johnson 1995) and *Eucalyptus*, which itself includes two major subgenera *Eucalyptus (Monocalyptus)* and *Symphyomyrtus*. Further subdivision of these subgenera into the formal and informal groups (following Hill 2002) is given in Table 2.

Ecological strategies

While many of the subgeneric groups align with groups based on bark characters that have been traditionally used in field identification and forestry work particularly, e.g. stringybarks, boxes, ironbarks, others cut across several groups e.g smooth-barked gums. However it is considered that further insights into the identification and ecology of the individual species might be gained from consideration of common attributes relevant to the groups. With this in mind, general ecological features that appear to be characteristic of particular groups, including soil nutrient conditions, habitat, flowering and fruiting timing and fire responses have been listed using data sourced from Benson & McDougall (1998) together with our general field observations on the species. Eucalypts have evolved to occupy a very wide range of habitats and some groups including *Angophora*, *Corymbia* and *Symphyomyrtus*–Adnataria include species with a very wide range of ecologies. In the GBMWHA eucalypts are only absent from rainforest and swamp sites. Competition for light at the seedling recruitment stage probably keeps them out of rainforest, as there are many eucalypts that grow on the high nutrient soils that are generally associated with rainforest. Most eucalypts need well-drained soils and are killed by extended waterlogging. However some species in Symphyomyrtus–Maidenaria do cope with some waterlogging (*Eucalyptus camphora*, *Eucalyptus aggregata*, *Eucalyptus ovata*) and could allow evolution of future swamp species.

In terms of Grime's (2001) CSR triangle of ecological strategies COMPETITORS — STRESS — TOLERATORS — RUDERALS, groups such as the *Eucalyptus*–Green-leaved ashes and *Symphyomyrtus*–Adnataria are very strong stress-tolerators, while *Symphyomyrtus*–Transversaria are strong competitors. The majority of species have components of both strategies however and this has probably contributed to their success. Ruderal strategy characteristics (short-life, quick growth, colonisers) show in a couple of species from different subgroups (*Eucalyptus oreades, Eucalyptus elata*) but are unusual. These strategies may provide some pictures of past dynamic changes. For example the stress-tolerator capacity of the *Eucalyptus*–Green-leaved ashes and their geographical distribution on ridges particularly in the upper Blue Mountains suggest they may have been able to survive in that area during the cold conditions of the Last Glacial Maximum 20 000 years ago, whereas competitor groups such as *Symphyomyrtus*–Transversaria may have been able to invade new areas as climate ameliorated 5–10 000 years ago.

Habitat and ecological ranges of GBMWHA eucalypts

Brief notes on the habitats of the individual species (Table 3) have been compiled predominantly from DECCW surveys (NPWS 2003, DEC 2004, DEC 2006, DEC 2006a & DECC 2008). Sources of information for those parts of the GBMWHA where survey is not complete were Bell (1998) for Wollemi National Park, Keith and Benson (1988) and Black (1982) for Kanangra Boyd National Park and Keith and Benson (1988) and Benson (1992) for the Grose valley.

The main landscape characteristic of the GBMWHA is the predominance of sandstone but within this is a considerable variation in local habitat conditions resulting from topographic variation, climate, slope and aspect, and soil fertility. The following factors contribute to the diverse range of habitats present in the GBMWHA.

Altitude and climate

Elevation in the GBMWHA ranges from 20 m elevation near the Nepean River at Glenbrook to 1 330 m elevation at Mt Emperor near Jenolan Caves. The lowest plateau in the GBMWHA is Yengo NP which has extensive areas below

Table 3. Notes on the habitats of individual Greater Blue Mountains World Heritage Area eucalypt species compiled predominantly from DECCW survey work.

Eucalypt species	Habitat/distribution
Angophora bakeri	• dry, colluvial slopes on Permian sediments below the escarpments of the Wollondilly, Nattai, Little River Valleys and around Lake Burragorang • ridges, upper slopes and lower slopes on sandstone below 400 m in southern Yengo and Wollemi, the Blue Labyrinth & Nattai • low ridges and plains with deep, freely draining sands on the Mellong Plateau
Angophora costata	• sheltered slopes and gullies and more exposed situations on dissected sandstone plateaus across the GBMWHA below 700 m • drier slopes on Permian sediments beneath the escarpment in the Megalong and Kedumba Valleys • larger volcanic diatremes at mid elevations in the Erskine Ranges
Angophora euryphylla	• sandstone outcrops from Mt Yengo area to Martindale Range (localised)
Angophora floribunda	• alluvium along major rivers, larger creeks and gullies on a variety of substrates throughout the GBMWHA • colluvial slopes beneath the escarpment across the GBMWHA • well drained sandy alluvium of the Mellong Swamps area • more limited among rocky pagodas between Dunns Swamp and Newnes Plateau
Angophora hispida	• exposed ridges north of Upper Colo and near Mt Lockyer (localised)
Corymbia eximia	• throughout Yengo on sandstone and sandstone with thin layers of shale, the Blue Labyrinth, the Blue Breaks and in limited parts of south east Wollemi
Corymbia gummifera	• more exposed and sheltered slopes on dissected sandstone plateaus across the GBMWHA below 700 m • drier slopes on Permian sediments beneath the escarpment in the Megalong and Kedumba Valleys, Tonalli Range and around Lake Burragorang
Corymbia maculata	• sandstone ridges and sheltered situations enriched by shale in a small area near Bulga
Corymbia trachyphloia subsp. *amphistomatica*	• exposed aspects on sandstone in low rainfall areas of northern Wollemi
Eucalyptus aenea	• dry ridges in north western Wollemi (localised)
Eucalyptus agglomerata	• the Bindook Highlands, steep slopes of the Wollondilly Valley and Scotts Main Range • more exposed and sheltered slopes on dissected sandstone plateaus at moderate elevations across the GBMWHA • dry colluvial slopes below the escarpment of the Kedumba, Nattai, Little and Burragorang Valleys
Eucalyptus aggregata	• moist alluvial soils associated with cold air drainage hollows and alluvial bogs at high elevations, Limeburners Flat, Murruin Range
Eucalyptus albens	• basalt caps and diatremes in low rainfall areas in low rainfall areas north of the Hunter Range • Devonian siltstone & limestone on lower slopes and drainage lines in the Capertee Valley • undulating foothills along the Wollondilly River and tributaries
Eucalyptus amplifolia subsp. *amplifolia*	• alluvial flats along streams and colluvial fans at the headwaters of streams in Big Yango & Wallabadah and Howes Valley area • volcanic diatremes of the Lower Blue Mountains and eastern Wollemi
Eucalyptus apiculata	• rock plates with skeletal sandy soils below 900m, eg Linden, Kings Tableland, Blue Labyrinth, Bonnum Pic
Eucalyptus baeuerlenii	• Darwins Walk on Jamison Ck
Eucalyptus baueriana	• alluvial flats along Putty Creek
Eucalyptus bensonii	• skeletal soils along the Wollemi Range between Cyrils Rocks and Gospers Mtn (very limited)
Eucalyptus benthamii	• alluvial flats in the Kedumba Creek, Reedy Creek, Little and Nattai River catchments
Eucalyptus beyeriana	• ridges and exposed slopes with shallow soils in eastern Wollemi below 400 m and the low rainfall areas of the Goulburn River catchment • basalt caps in low rainfall areas north of Nullo Mountain
Eucalyptus bicostata	• limited – Karst at Jenolan Caves • high altitude >900m basalt caps in high rainfall areas, eg Mt Nullo Mountain, Cedar Creek • sheltered gullies and protected slopes at higher elevations on Gangerang & Murruin Range

Eucalypt species	**Habitat/distribution**
Eucalyptus blakelyi	• shallow sandy soils in sheltered situations in the low rainfall areas of north west Wollemi • diatremes in low rainfall areas north of Nullo Mountain • undulating topography on the floor of the Capertee & Wolgan Valleys, eg Crown & Barton Creeks
Eucalyptus blaxlandii	• sheltered slopes & ridges on Ordovician, Silurian and Devonian metasediments between 800 and 1000m, Black Range, Jenolan Caves, Gangerang Range to Limeburners trail; • Bindook Highlands and the steep slopes of the Wollondilly Valley • high altitude >900 m basalt caps in high rainfall areas, eg Budthingeroo, Mt Cameron • gullies among rocky pagoda complexes; sheltered slopes and ridges with deeper soils on sandstone • on trachyte at Mt Jellore (limited)
Eucalyptus bosistoana	• Bindook Highlands and the steep slopes of the Wollondilly Valley • occasional on sheltered aspects along the Jenolan, Coxs and Kowmung Rivers and larger tributaries
Eucalyptus bridgesiana	• rocky slopes around Wombeyan Caves (currently outside GBMWHA), • higher altitude diatremes in high rainfall areas above 500 m, eg Box Hole Clearing • sandy soils along creeks around the Cudgegong River (limited) • slopes along Murruin Creek, Jocks Creek and the Wollondilly River • cold air drainage hollows and alluvial bogs at high elevations, Limeburners Flat, Murruin Range
Eucalyptus burgessiana	• rock plates with skeletal soils below 900 m, eg Kedumba Walls, Axehead Mountain, Laeys Tableland, Golden Moon Bluff ridge, the Lower Blue Mountains
Eucalyptus caleyi subsp. *caleyi*	• ridges and slopes in low rainfall areas in the Goulburn River catchment
Eucalyptus camphora subsp. *camphora*	• waterlogged soils on the footslopes of the Megalong Valley below Narrow Neck • poorly drained alluvial sands possibly associated with impermeable clays in Never Never & Ganguddy Creeks
Eucalyptus cannonii	• talus slopes below the escarpment and protected gullies between Growee Gulph and the Capertee valley • undulating topography on the floor of the Capertee & Wolgan Valleys, eg Crown & Barton Creeks
Eucalyptus capitellata	• Near the Macdonald River (localised)
Eucalyptus conica	• Fertile soils in north western Wollemi (localised)
Eucalyptus consideniana	• ridges and exposed slopes in Wollemi south of the Hunter Range below 800 m, and Blue Labyrinth
Eucalyptus corticosa	• shallow sandstone soils on ridges around the Cudgegong River (localised)
Eucalyptus crebra	• dry & sheltered slopes through the Coxs, Jenolan, Kowmung, Nattai, Little and Burragorang valleys • colluvial slopes below the escarpment along Lake Burragorang between the Kedumba and Wollondilly Valleys • upper slopes and undulating ridges along Scotts Main Range and the Bindook Highlands • ridges and protected slopes on sandstone with interbedded layers of shale in Yengo and Wollemi • shale caps and volcanic diatremes of the Lower Blue Mountains and eastern Wollemi, eg The Ironbarks, Euroka, Machins Crater, St Helena Crater • Capertee Valley on Permian sediments
Eucalyptus cunninghamii	• rock plates with skeletal soils on Kings Tableland, plateaus near Jamison valley & upper Grose
Eucalyptus cypellocarpa	• sheltered slopes and gullies at high elevations from Black Range and Jenolan Caves to Murruin Range, Bindook Highlands and steep slopes of the Wollondilly Valley • protected sandstone gullies, sheltered slopes and among rocky pagodas across the GBMWHA • slopes beneath the escarpment in the Megalong, Jamison and Kedumba Valleys, High Gangerangs, Coxs River arm of Lake Burragorang and Newnes Plateau
Eucalyptus dalrympleana subsp. *dalrympleana*	• moist, sheltered situations at high elevations from Black Range, Jenolan Caves and Boyd Plateau to Murruin Range and the Bindook Highlands • ridges and sheltered slopes on and around Newnes Plateau
Eucalyptus dawsonii	• talus slopes below the escarpment in low rainfall areas between Growee Gulph and Jerrys Plains
Eucalyptus deanei	• deeper colluvial soils on Permian sediments on protected escarpment midslopes and benches from the Kedumba & Jamison Valleys to the Nattai & Burragorang Valleys • deep, protected gullies and sheltered slopes on sandstone and Silurian and Devonian metasediments in higher rainfall areas of GBMWHA • volcanic diatremes of the lower Blue Mountains
Eucalyptus dendromorpha	• localised on higher elevation sandstone plateaus e.g., Kings tableland, Wentworth Falls, Narrowneck, Govetts Leap and Mt Banks
Eucalyptus dives	• exposed sites above 900m at Jenolan Caves, undulating terrain the Boyd Plateau • poorly drained headwaters of creeks on the Newnes Plateau

Eucalyptus dwyeri	• exposed aspects in low rainfall areas of northern Wollemi
Eucalyptus elata	• sheltered situations on Murruin Range, Bindook Highlands and steep slopes of the Wollondilly Valley • escarpment footslopes on Permian sediments in Burragorang, Nattai, Megalong and Kedumba Valleys • sheltered positions on sandstone across the Nattai and Wanganderry Tablelands; • alluvial flats along major streams in the Little and Nattai River catchments
Eucalyptus eugenioides	• dry & sheltered sites through the Coxs, Jenolan, Kowmung, Nattai, Little and Burragorang catchments • colluvial slopes below the escarpment on both sides of Lake Burragorang betweeen the Megalong and Wollondilly Valleys • upper slopes and undulating ridges along Scotts Main Range and the Bindook Highlands and steep protected slopes of the Wollondilly Valley • residual shale caps and interbanded shale soils on sandstone ridges of the Lower Blue Mountains • localised colluvial fans in gullies and diatremes in Big Yango, Wallabadah, Werong Creek & Devils Hole area
Eucalyptus fastigata	• sheltered locations at the high elevations from Black Range, Jenolan Caves & Boyd Plateau to Murruin Range and the Bindook Highlands • gullies & sheltered slopes below escarpment on Newnes Plateau • high altitude basalt caps (limited), eg Budthingeroo
Eucalyptus fergusonii subsp. *dorsiventralis*	• enriched soils on gentle slopes, ridges and benches in central and northern Yengo and eastern Wollemi
Eucalyptus fibrosa	• colluvial slopes below the escarpment along Lake Burragorang between the Kedumba and Wollondilly Valleys, and below Newnes Plateau • ridges and slopes on sandstone or soils enriched by shale in Yengo, Wollemi, the Blue Breaks and Nattai • slopes of the Jenolan, Coxs and Kowmung Rivers and Scotts Main Range • shale caps on ridges of the Lower Blue Mountains, eg The Ironbarks • ridges and upper slopes within the Capertee valley on Permain sediments
Eucalyptus fracta	• Sentry Box Point near Milbrodale (localised)
Eucalyptus globoidea	• sandstone ridges enriched with shale bands and exposed upper slopes of the Blue Breaks, southern Blue Labyrinth, Nattai, Wanganderry and Burragorang Tablelands • higher shale caps in south east Wollemi, Blue Labyrinth & Nattai, eg Culoul Range, Wattle Ridge • upper slopes and crests along southern Scotts Main Range and the Bindook Highlands
Eucalyptus hypostomatica	• slopes and benches below escarpment in the Burragorang and Nattai Valleys • mid to lower south and east facing slopes on Narrabeen sediments across central and northern Yengo • scattered occurrences on sheltered sites in the tributaries of the Coxs & Kowmung Rivers
Eucalyptus laevopinea	• high altitude >900m basalt caps in high rainfall areas, eg Mt Coricudgy, Nullo Mtn
Eucalyptus laophila	• between sandstone pagodas in western Wollemi at elevations < 800 m
Eucalyptus ligustrina	• localised on rock plates with skeletal sandy soils below 900m, eg Kedumba Walls, Kings Tableland, Capertee valley
Eucalyptus macarthurii	• Boyd Plateau (localised)
Eucalyptus macrorhyncha	• Permian talus slopes below the escarpment in higher elevation areas between Growee Gulph and the Capertee valley • exposed ridges and slopes with skeletal soils on Ordovician metasediments west of Pantoneys Crown • slopes along Murruin Creek, Jocks Creek and the Wollondilly River
Eucalyptus mannifera subsp. *gullickii*	• poorly drained headwaters of creeks on sandstone on the Bindook Highlands, Narrow Neek Ti-Willa and Newnes Plateaus, eg Deanes & Rocky Creek • low relief situations in the upper Cudgegong catchment
Eucalyptus mannifera subsp. *mannifera*	• moderately sheltered, rocky positions on metasediments on slopes between 800 and 1000m, Gangerang Range to Limeburners trail
Eucalyptus melliodora	• foothills and slopes on Bindook Porphyry in the Burragorang Valley between Joorilands and Murruin Creek • slopes on Devonian sediments in the Jenolan, Coxs and Kowmung Rivers and Scotts Main Range • localised diatremes, eg Werong Creek, Devils Hole • hills of the Capertee & Wolgan Valleys, eg Crown & Barton Creeks (limited)
Eucalyptus michaeliana	• mid to lower south and east facing slopes on Narrabeen sediments across central and northern Yengo

Eucalypt species	**Habitat/distribution**
Eucalyptus moluccana	• undulating hills and escarpment footslopes on Permian sediments and on Bindook Porphyry along the Wollondilly River and tributatries and the lower Nattai & Kedumba Valleys • mid to lower protected slopes on Narrabeen sediments and shale capped ridges in central and northern Yengo • basalt caps diatremes in low rainfall areas of Yengo and Wollemi, eg Mounts Wareng and Yengo, Sandy Camp, Kerrabee/Woodlands Trig • steep, dry escarpment slopes on Permian sediments above the floor of the Hunter Valley in Yengo and Wollemi • on limestone around Crown Creek, Capertee Valley • rainshadow areas in the Coxs & Kowmung catchments
Eucalyptus moorei	• skeletal sandy soils at elevations greater than 700m, eg Kanangra Walls, Narrow Neck, Ti Willa Plateau, Gangerang Plateau
Eucalyptus muelleriana	• moderately deep soils on the Bindook Highlands, eg Bullnigang Heights, Tomat Creek to Nyanga Mountain
Eucalyptus multicaulis	• rock plates with skeletal sandy soils below 900m, eg Kings Tableland, western Wollemi
Eucalyptus notabilis	• interbanded and residual shale soils on sandstone ridges of the Blue Labyrinth and Blue Breaks
Eucalyptus nubila	• ridges and slopes in low rainfall areas in the Goulburn River catchment (limited) • hills near Watch House Creek (limited)
Eucalyptus obliqua	• moist, sheltered slopes and gullies of the high elevations from Black Range, to Murruin Range to the Bindook Highlands
Eucalyptus oreades	• sheltered slopes and gullies between Kings Tableland and Newnes Plateau, often above escarpment cliffs • sheltered positions on the Nattai and Wanganderry Tablelands
Eucalyptus ovata	• tableland soaks associated with swamps the Bindook Highlands, eg Tomat, Random, Back and Colong Swamp • along gently sloping drainage lines on the of the Boyd Plateau and at upper Martins Creek
Eucalyptus paniculata subsp. *paniculata*	• residual shale caps on ridges of the Lower Blue Mountains and south east Wollemi, eg The Ironbarks, Culoul Range
Eucalyptus parramattensis subsp. *parramattensis*	• better-drained and permanently wet sites on deep sands in the Garland Valley and Mellong Swamps area • sandy drainage flats adjoining the eastern side of Thirlmere Lakes (limited) • colluvial soils along the larger creeks of the western Capertee valley (limited)
Eucalyptus pauciflora	• on undulating terrain or in cold hollows on granite on the Boyd Plateau and around Jenolan Caves • cold air drainage hollows. alluvial bogs and rock plates at high elevations on the Loombah Plateau, Bindook Highlands, Murruin Range and Mt Fatigue trail
Eucalyptus pilularis	• enriched sandstones between the Warragamba River and Erskine Creek • shale influenced ridges, slopes and gullies of the Oakdale Plateau, eg Green Hill, Waterfall Creek, Pumpkin Hill (limited)
Eucalyptus piperita	• slopes, gullies and ridges with deeper soils on sandstones across much of the GBMWHA, except the low rainfall northern areas • residual Permian outcrops on Scotts Main Range; colluvial slopes below escarpment of the Tonalli Range, southern Blue Labyrinth and Newnes Plateau • rocky soil on residual plateaus or ridges, High Gangerangs to Black Range
Eucalyptus polyanthemos subsp. *polyanthemos*	• talus slopes below the escarpment in the Wolgan and Capertee valleys
Eucalyptus praecox	• north of Rowans Hole (limited), Dunns Swamp
Eucalyptus prominula	• dry rocky exposed ridges and upper slopes on sandstone south of the Old Settlers Trail in Yengo, and eastern Wollemi
Eucalyptus punctata	• possibly the most frequently recorded and widespread Eucalypt of the GBMWHA, occurring on a variety of substrates, in wetter and dry areas and in all but the coldest sites • occurs on ridges, slopes, gullies and talus on sandstone, Silurian and Devonian metasediments, Bindook Porphyry, Permian sediments, volcanic breccia, shale, granite, alluvium and colluvium.
Eucalyptus quadrangulata	• between Yerranderie and the Bindook Highlands (limited) • scattered occurrences on sheltered sites in tributaries of the Coxs & Kowmung Rivers
Eucalyptus radiata subsp. *radiata*	• sheltered situations at high elevations from Black Range, Jenolan Caves and Boyd Plateau to Murruin Range to the Bindook Highlands on a variety of substrates • small sheltered drainage lines on sandstone above southern escarpment from Katoomba to Wentworth Falls and Newnes Plateau • sheltered slopes beneath the escarpments in the Megalong and Kedumba Valleys • high altitude >900m basalt caps in high rainfall areas
Eucalyptus ralla	• dry colluvial slopes below the escarpment on both sides of Lake Burragorang betweeen the Kedumba and Wollondilly Valley
Eucalyptus resinifera subsp. *resinifera*	• higher ridgelines with shale caps in south east Wollemi, eg Culoul Range (limited) • broad flat to gently sloping sites on plateaus north of Oakdale, *southern Blue Labyrinth and Blue Breaks*

Eucalyptus rossii	• below 800 m on ridges with shallow soils on Ordovician metasediments in western Wollemi and the Capertee valley • talus slopes below escarpment of Newnes Plateau and Donkey Mountain • sheltered slopes and valleys among rocky pagodas
Eucalyptus rubida subsp. *rubida*	• on undulating terrain or in cold hollows on granite on the Boyd Plateau
Eucalyptus saligna	• protected gullies and sheltered lower slopes on Narrabeen sediments mainly in northern Yengo • colluvial fans at the headwaters of gullies in Big Yango & Wallabadah area • sheltered gullies and lower slopes in eastern Wollemi, usually on soils enriched by shale or basalt, eg Culoul Range
Eucalyptus scias subsp. *scias*	• Culoul Range (localised)
Eucalyptus sclerophylla	• ridgetops and exposed slopes on sandstone plateaus above 600m, eg Narrow Neck, Tonalli Mountain, Lacys, Nattai and Wanganderry Tableland, • lower elevation and higher rainfall areas of the south-eastern corner of Yengo • Permian outcrops on Scotts Main Range and on footslopes around the edge of the Megalong & Burragorang Valleys • better-drained and wetter sites on deep sands in the Garland Valley and Mellong Swamps area
Eucalyptus sideroxylon	• ridges and slopes in low rainfall areas in the Goulburn River catchment • exposed dry slopes along the Coxs, Jenolan and lower Kowmung River valleys below 550 m
Eucalyptus sieberi	• high elevation plateaus, ridges and slopes between 800 and 950m, Bindook Highlands, north from Little Wombeyan Creek, Kanangra area, Boyd Plateau, High Gangerang, Black & Moorara Range, Jenolan Caves • rocky areas, ridgetops and exposed slopes on sandstone, south from the Capertee valley • residual Permian outcrops on Scotts Main Range • slopes of the Nattai and Wanganderry Tablelands
Eucalyptus smithii	• sheltered and more exposed sites from Bindook Highlands to Black Range
Eucalyptus sparsifolia	• slopes, gullies and ridges on sandstone and enriched shale soils across the GBMWHA mostly below 800 m • Permian outcrops on Scotts Main Range and on talus slopes below escarpment of Newnes Plateau and Donkey Mountain • skeletal, often rocky soil on residual plateaus or ridges, High Gangerangs, Black Range and Jenolan Caves • footslopes around the edge of the Megalong & Jamison Valleys on Permian sediments • better-drained sites on deep sands in the Garland Valley and Mellong Swamps area • Bindook Highlands and northern fall of the Wollondilly Gorge • slopes along the Coxs, Jenolan and lower Kowmung River valleys
Eucalyptus squamosa	• exposed sites in the lower elevation and higher rainfall areas of the south-eastern Yengo and north of Upper Colo in south east Wollemi
Eucalyptus stellulata	• cold air drainage hollows and alluvial bogs at high elevations, Boyd Plateau, Limeburners Flat, Murruin Range, Tomat, Random, Back, Colong and Bent Hook Swamps
Eucalyptus stricta	• rock plates with skeletal sandy soils at higher elevations, eg Kanangra Walls, Narrow Neck, Ti Willa Plateau, Gangerang Plateau, Kedumba Walls, Axehead Mountain, Loombah Plateau, along the Murruin Range and Mt Fatigue trail
Eucalyptus tenella	• along the divide between the Growee & Cudgegong catchment, eg Heffrons Gap • broad valley floors, ridges and upper slopes within the Capertee valley
Eucalyptus tereticornis	• sheltered & dryer slopes on Devonian sediments in the Jenolan, Coxs and Kowmung Rivers, their larger tributaries and along Scotts Main Range • deeper colluvial soils below escarpment on protected aspects in the the Coxs River arm of Lake Burragorang, the Kedumba, Burragorang, Nattai and Little River Valleys; • slopes & undulating foothills of the Wollondilly River & tributaries on Bindook Porphyry • volcanic diatremes of the lower Blue Mountains and south east Wollemi below 400 m, eg Euroka, Machins Crater, Saint Helena Crater • moist sandy alluvium in the Mellong Swamps area, and footslopes and alluvial flats along broader streams around Howes Valley and along the Nattai & Little Rivers • basalt caps, shale capped ridges and enriched mid slopes in north-western Yengo and north east Wollemi, eg Mounts Wareng and Yengo
Eucalyptus viminalis	• Bindook Highlands and protected slopes of the Wollondilly Valley • on gentle slopes across the Boyd Plateau on granite, especially around eastern & northern plateau rim • high altitude basalt caps and diatremes in high rainfall areas, eg Budthingeroo • sheltered sites at high elevations from Jenolan Caves & the Black Range to Murruin Range • freely drained alluvial soils along drainage lines on the Mellong sandmass and sheltered streams • along larger streams and among rocky pagodas between Dunns Swamp and Newnes Plateau

300 m elevation. The remainder of the GBMWHA is usually higher than 400 m elevation, other than the larger incised valleys such as the Coxs and Grose Rivers. Only a relatively small part of the GBMWHA is above 1 000 m elevation, mainly around Mount Werong, the Boyd Plateau and Narrow Neck Peninsula. A notable feature of the GBMWHA is the high level of vertical relief between the plateaus and incised valleys, which reaches a peak of about 900 m in the south west of the area.

As the altitude increases, the climate becomes colder and wetter. Frost, fog and some snow can occur in the Upper Mountains, where conditions are generally colder and harsher. Species restricted to the coldest areas include *Eucalyptus pauciflora* and *Eucalyptus laevopinea* on the high peaks, and *Eucalyptus rubida, Eucalyptus stellulata* and *Eucalyptus aggregata* on flats subject to cold air drainage. The climate is much warmer in the lower eastern and northern areas; those species typically found at lower elevations such as *Angophora costata* and *Corymbia eximia* usually have a widespread distribution within the GBMWHA.

Rainfall

Annual rainfall over most of the GBMWHA is moderate (800–1200 mm pa) but increases with elevation to 1400 mm in the central Blue Mountains (Katoomba to Newnes Plateau) and in Kanangra – Boyd NP. Rainfall progressively decreases north of Newnes Plateau and is lowest in the northwest of the GBMWHA, in northern Wollemi. Jerrys Plains near the northern boundary of Wollemi NP has an annual rainfall 640 mm, which is probably representative of this part of the World Heritage area. Taxa that are more widespread on the NSW Western Slopes such as *Corymbia trachyphloia* subsp. *amphistomatica, Eucalyptus dawsonii* and *Eucalyptus beyeriana* only occur in this part of the GBMWHA.

Rock types

The oldest rocks of the GBMWHA are of Siluro-Devonian age and are mainly found in the southern Blue Mountains. Tectonic plate movements and volcanic intrusions have caused considerable deformation to them. Deposition of the Sydney Basin sediments commenced in the early Permian with marine sediments and coal deposits which outcrop below the major escarpments. The sandstones that are so extensive across the region were deposited next, as river sediments in late Permian to mid Triassic. More fertile shales were occasionally deposited above these sandstones. The most recent phase were the basalt flows of the Miocene, which remain as caps on a number of mountains.

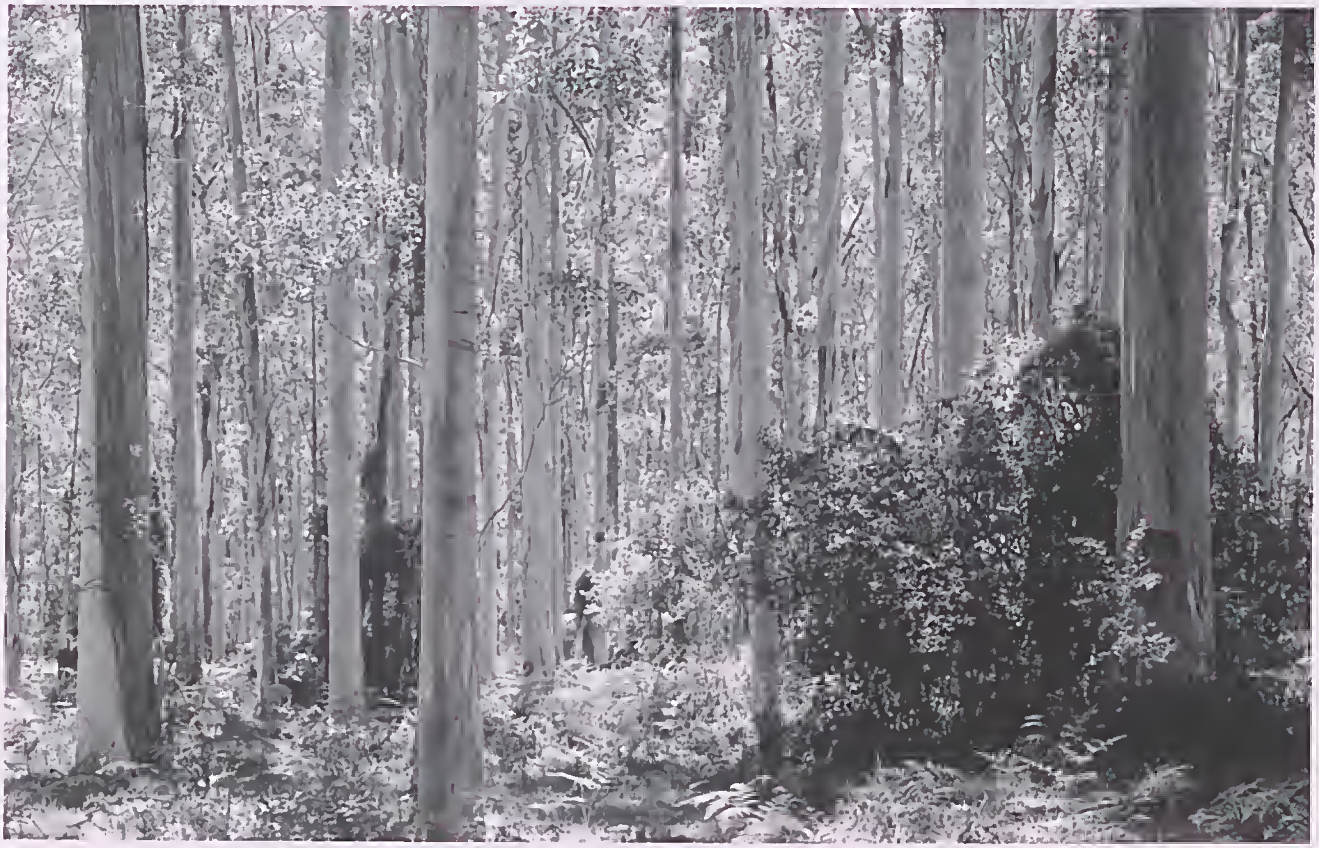

Fig. 3. Smooth straight trunks of *Eucalyptus deanei* in Blue Gum Forest in Blue Mountains National Park

Through the processes of weathering, rock breaks down into soil – some rocks create more fertile, higher nutrient soils than others. The sandstones break down into low nutrient soils which hold little moisture. There are many eucalypts typical of low nutrient sandstones including *Angophora bakeri*, *Angophora hispida*, *Corymbia gummifera*, and many of the subgenus *Eucalyptus* such as the *Eucalyptus*–Green-leaved ashes and *Eucalyptus* Blue-leaved ashes B. The quartzites typical of the rugged valley of the mid Coxs River produce low nutrient soils, where *Eucalyptus sieberi* and *Eucalyptus punctata* commonly occur. The Permian coal measures, shale and volcanic rocks such as basalt and porphyry form a brown, loamy soil which is high in nutrients and retains more moisture. Distinctively different plant communities occur on these soils, dominated by tall eucalypts such as *Eucalyptus deanei, Eucalyptus fastigata* or *Eucalyptus muelleriana*. Localised areas of basalt may have *Eucalyptus saligna* or *Eucalyptus viminalis* in higher rainfall areas or *Eucalyptus albens* and *Eucalyptus moluccana* in drier areas. Rainforests are largely restricted to the higher nutrient soils in the highest rainfall areas.

Drainage

The often steep topography in the sandstone areas generally allows water to run off rapidly but where there are layers of impervious rock, such as claystone or ironstone, waterlogged conditions may occur allowing swamp communities to develop. Most eucalypt species are sensitive to waterlogged conditions and they rarely occur in poorly-drained sites. An exception is *Eucalyptus camphora* found in swamps in the Rylstone area. Species in alluvial habitats may recruit in temporarily wet sites after floods e.g. *Eucalyptus benthamii, Eucalyptus elata*.

Aspect

The aspect of the slope determines how much sunlight it gets, and which winds it is more exposed to. In general, north-facing slopes are drier and hotter, supporting a different suite of smaller eucalypts than south-facing slopes. Exposed sites associated with cliff-lines in the upper mountains may frequently have the mallees e.g. *Eucalyptus cunninghamii, Eucalyptus stricta,* though these sites are also influenced by drainage and slope characteristics.

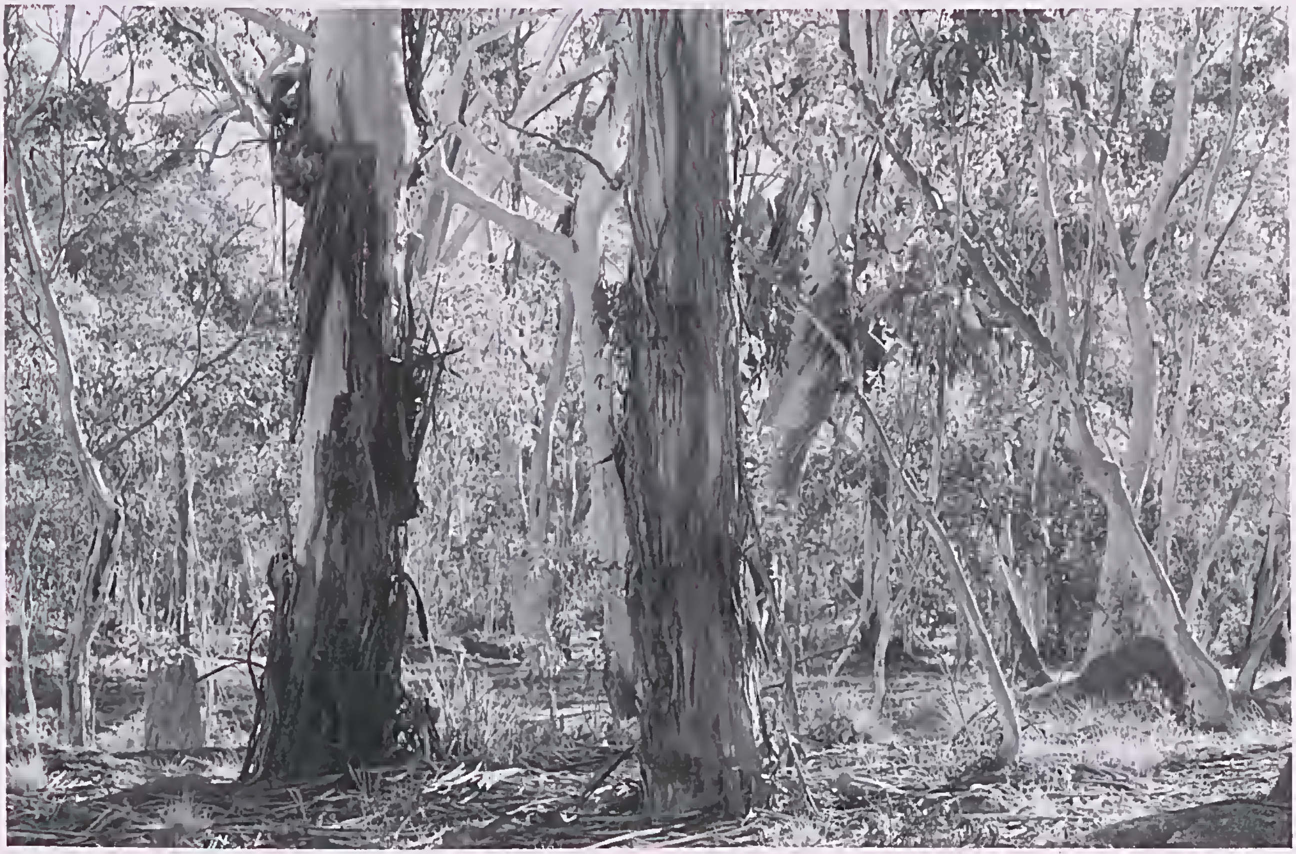

Fig. 4. Mountain Gum forest in Kanangra-Boyd National Park. Large shaggy trunks of *Eucalyptus dalrympleana* with smaller trees of *Eucalyptus pauciflora*, Snow Gum, in background.

Slope

The steeper a slope, the more quickly water will run off, taking nutrients with it. The combination of slope and aspect has a profound effect on the eucalypt species present. South-facing slopes in the Blue Mountains are generally moister and steeper than north-facing (Holland et al 1992) and have different eucalypt species, particularly on the lower slopes where moisture can accumulate e.g. *Eucalyptus saligna, Eucalyptus cypellocarpa.* On the other hand, north-facing slopes more frequently support species tolerant of stronger sunlight and drier soils such as *Eucalypus fibrosa* or *Eucalyptus crebra.*

Fire, disturbances

Fire plays an important role in the growth and development of vegetation communities in Australia. After fire most eucalypt trees regenerate from dormant epicormic buds along the trunk or major branches. In some species particularly the mallees, the canopy and stems are killed and the plants resprout from underground lignotubers. Species which resprout may also shed seeds from capsules and recruit seedlings as well. A few species most notably *Eucalyptus oreades* are killed by fire and release their seeds into the ground that has been cleared by flame and made more fertile with ash. An interesting aspect of the reproductive strategy of *Eucalyptus oreades* is early seed production in trees with suppressed growth relative to dominant trees. This acts as a hedge against another fire in the period before the dominant trees reach maturity (Glasby et al, 1988).

Some species such as the *Angophora* species shed their seed annually with recruitment depending on rainfall conditions. Indeed rather than being particularly *fire-dependent* species as is sometimes claimed, many are dependent on disturbance conditions that provide suitable conditions for seedling recruitment e.g. the creation of bare areas following soil movement, flood alluvium, grazing, drought or sometimes fire. Saplings will often be seen on the edges of disturbed sites such as roadsides. *Eucalyptus oreades* will successfully establish along roadsides and in gardens in the absence of fire (DHB pers obs.).

Biogeographic variation

The GBMWHA extends from the Hunter Valley in the north to the Southern Highlands and is centred on the Central Coast and Central Tablelands botanical divisions of NSW, but includes parts of the Central Western Slopes and the North Coast divisions. The northern part of the region includes some eucalypts such as *Eucalyptus laevopinea* that are more widely distributed in northern NSW and Queensland. A disjunct population of *Eucalyptus nobilis*, a species more typical of the Northern Tablelands, has been discovered near Mount Coricudgy during a current survey of Wollemi NP (Stephen Bell pers. com.) will not be included in the list until the survey and identifications have been completed. In the dry areas of northern Wollemi NP are eucalypts that occur primarily on the NSW western slopes such as *Corymbia trachyphloia* subsp. *amphistomatica*. The southern part of the GBMWHA has several eucalypts that are widely distributed in southern NSW and Victoria, including *Eucalyptus smithii, Eucalyptus aggregata* and *Eucalyptus muelleriana.*

Eucalypts and climate change

Changes in rainfall, evaporation, temperature and carbon dioxide levels associated with climate change are likely to alter the patterns of mortality, growth and phenology of individual eucalypts. It is likely that different species will respond differently to these changes, and that species will vary in their level of tolerance to these changes. Those species with a more plastic response may be advantaged over those with limited tolerance to change. As eucalypt seeds do not move very far in the landscape, large scale movement of individual eucalypt species in response to changing conditions is not likely, though there may be in-situ change (Dunlop & Brown 2008), where some species already present in the GBMWHA will be favoured by climate change and may increase in abundance, while others may decline. The result of this process is likely to be shifts in the relative abundance of different eucalypt species.

In the Blue Mountains much of the wet sclerophyll forest occurs as relatively small patches within a matrix of drier forest. These patches are vulnerable to regular fire, especially where their topographic position does not offer protection from fire. The shale cap forests of the Blue Mountains are especially vulnerable because they occur on hill tops. The wet forests occurring as narrow bands along watercourses in the sandstone gorges are similarly vulnerable. The loss of limbs and foliage in dry periods may contribute to fire risk. Some canopy dominants typical of wet sclerophyll forest are weak resprouters (e.g. *Eucalyptus deanei*). Hence, they would be vulnerable to regular, intense fire. Regeneration of *Eucalyptus deanei* from seed may also be compromised by intense fire. It sheds its seed at maturity, with germination mainly occurring on bare ground that has been exposed following a low intensity fire or other periodic disturbance. Its capsules are not very woody and would be likely to burn in an intense crown fire. On the other hand it is possible that some capsules and seed may be blown long distances in the updraughts associated with such a fire, as are leaves and twigs.

Conclusion

The 96 eucalypts (55 widespread, 41 restricted) known from the GBMWHA occupy a very wide range of habitats being really only absent from rainforest and swamp sites. The majority of species have components of both stress-tolerator and competitor strategies and this has probably been a main contributor to their success. While we have been able to make some generalisations about the habitat of many of the eucalypts, details of the ecology of most species are still poorly-known. How they will respond to the changed conditions as temperatures increase, available moisture changes and fire patterns change is impossible to predict with our current knowledge. To guide management in conserving all these species for future generations we definitely need more research on the ecology of these dominants of the Australian forests.

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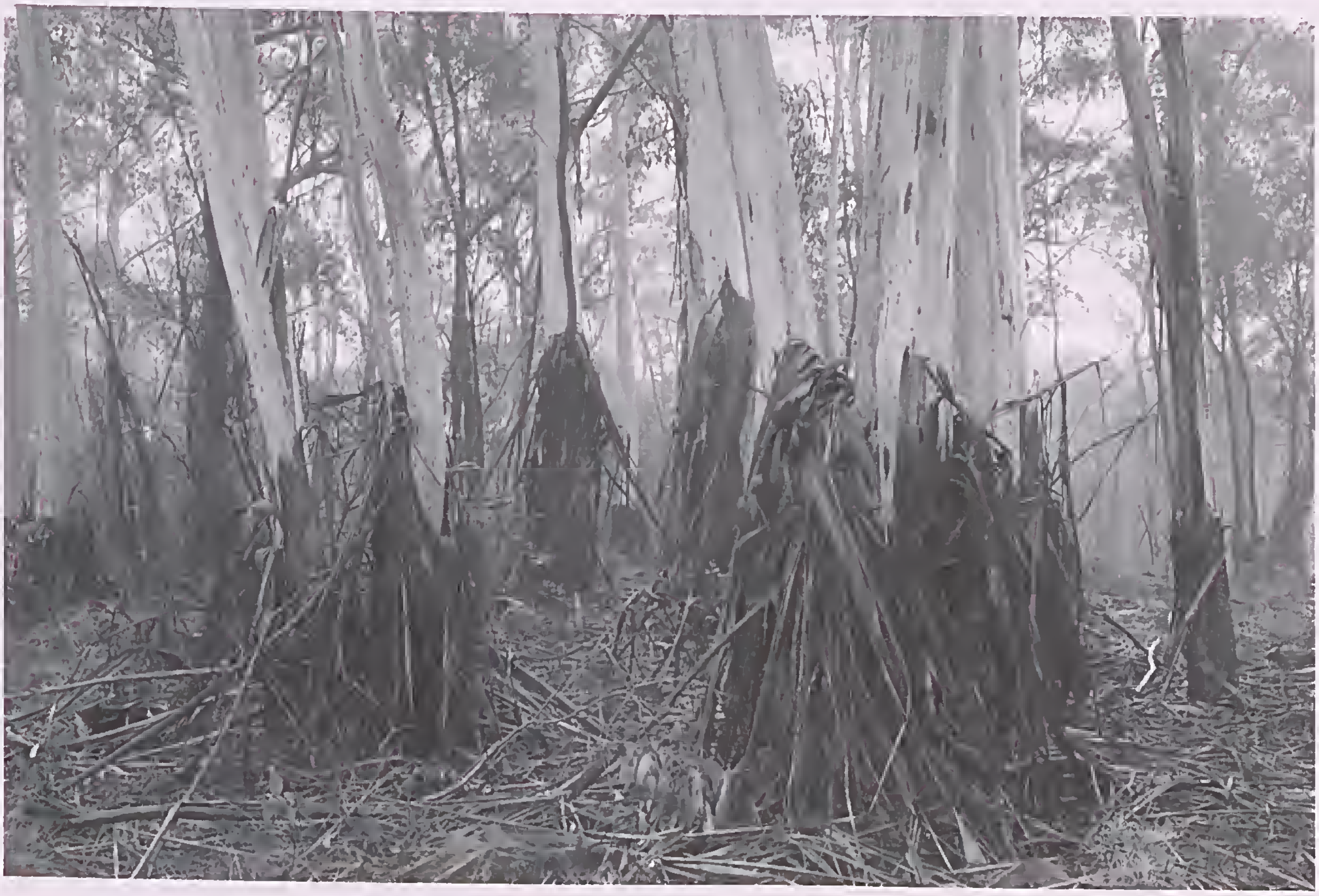

Fig. 5. Unlike most eucalypt species, mature *Eucalyptus oreades* trees (Blue Mountains Ash) are killed by fire; vigorous post-fire seedling recruitment leading to groves of even-aged saplings as here in the misty forests of Blue Mountains National Park.

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28 years of vegetation change (1978–2006) in a calcareous coastal dune system

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***Abstract*:** Changes in vegetation structure and composition over a 28 year period (1978–2006) following removal of human-induced disturbances, were examined in a calcareous coastal dune system in Point Nepean National Park (38° 19'S, 144° 41'E) in south-eastern Victoria, Australia. In the early 1980s human habitation of Point Nepean was abandoned and disturbance regimes such as burning, slashing and land clearing were altered or removed, providing an opportunity to study the recovery of disturbed coastal vegetation. Broad-scale and community-level vegetation changes were assessed by comparing quadrat and GIS mapping data from 1978 with data collected in 2006. Results indicate a change in broad vegetation patterns; shrubland vegetation has replaced hind dune grasslands and disturbed areas and there has been a decrease in exposed coastal areas (such as blowouts, dunes and cliffs), and an increase in woody native species and highly invasive woody weeds. The changes highlight the importance of incorporating vegetation states in planning management actions in dynamic coastal vegetation.

Key words: invasion, coastal woodlands, disturbance, woody weeds, Nepean Peninsula

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Introduction

Woody plant invasion is a widespread phenomenon in Australia (e.g. Bennett 1994, Costello *et al.* 2000, Lunt *et al.* 2010) and overseas (van der Maarel *et al.* 1985, McMahon *et al.* 1996, Zbigniew and Stefania 2007). Invasion can be triggered by changes in land management, in particular reductions in the frequency or intensity of disturbance (Bennett 1994, Costello *et al.* 2000). In many Australian temperate coastal ecosystems, exclusion of post-European disturbances (e.g. livestock grazing, clearing) in the second half of the 20th century has been an intentional management action to facilitate vegetation recovery. Classical theories of vegetation succession underlie this management approach. While re-establishment of woody plant species in previously cleared coastal dune ecosystems has been documented (Burrell 1981, Molnar *et al.* 1989, Bennett 1994, Costello *et al.* 2000), there is little data to support the assumption that directional succession toward the pre-European vegetation communities is occurring. Change or alteration of disturbance regimes in coastal systems often increases the proportional representation of woody species (Burrell 1981, Weiss and Noble 1984, Molnar *et al.* 1989, Bennett 1994, Costello *et al.* 2000), however, these increases are often within communities in which they were previously absent or rare (Moxham *et al.* 2009*a*). General observations of increasing woody plant cover may also ignore on-going declines in previously abundant woody plant species (e.g. *Banksia integrifolia*).

Classical studies of coastal dune systems highlight the role of salt, wind, topography, climate, rate of erosion and deposition of sand, and soil composition in determining zonal patterns of vegetation (Patton 1934, Lewis 1982). The influence of these factors varies with distance from the seaward side (Patton 1934). Within vegetation zones, as successional phases in the dune system occur, organic matter accumulates and soil acidification takes place, increasing the amount of available phosphorus, the presence of sodium in the soil and the soil pH decreases (Patton 1934, Karle *et al.* 2004), facilitating establishment of the taller long-lived woody vegetation in this more protected soil rich environment. Based on these assumptions Burrell (1981) simplifies southern Australian coastal transitions into five dominant phases and zones: (1) strand plants, (2) dune grasses and sand binding species on

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the foredunes, (3) hind dune communities of (3A) closed-scrub graduating into (3B) low closed-forest up to 10 m high, and (4) low-open forest to low woodland (with or without *Eucalyptus* species).

European disturbance of coastal ecosystems of south-eastern Australia in the 19th and 20th centuries resulted in the removal of the taller woody plant species (e.g. species of *Allocasuarina, Acacia, Eucalyptus* and *Banksia*) particularly in hind dunes supporting phases (3) to (4); leading to invasion by *Leptospermum laevigatum* and *Acacia sophorae* (Coast Wattle) scrub in some instances (Burrell 1981, Weiss and Noble 1984, Molnar *et al.* 1989, Bennett 1994, Costello *et al.* 2000, Moxham *et al.* 2009*a*, Lunt *et al.* 2010). Disturbance regimes, such as fire, that regulate ecological dynamics were altered; grazing by native herbivores was replaced by more intense domestic livestock grazing regimes (Moxham *et al.* 2009*a*). A key question is whether removal of recent human disturbance in these hind dune ecosystems results in the vegetation reverting to the patterns expected under the classical model of dune vegetation transition or does it tend towards novel vegetation types?

This study examines changes in vegetation structure and composition in a calcareous coastal dune system on Point Nepean, Victoria, over a 28 year period (1978–2006). The area has had a varied history of management, since European settlement in 1835 including military occupation and has been managed as a National Park since 1988, when direct human disturbance was removed (McGregor & Johnstone 1987, Moxham *et al.* 2009*a*). The vegetation was surveyed in January 1978 and re-surveyed in 2006, and the two datasets examined for patterns of vegetation change.

Methods

Site description

Point Nepean National Park (38° 19'S, 144° 41'E) (575 ha in area) is on the southern tip of the Nepean Peninsula, approximately 60 km south of Melbourne in southern Victoria, Australia. It is bordered by the high tide mark to the north, south and west and landlocked on the east. The park has a maritime climate of hot summers (daily average 12 – 25°C) and mild wet winters (daily average 6.5 – 13°C) with a mean annual rainfall of 736 mm (Mornington station 086079, Australian Bureau of Meteorology 2006). The geology of the region dates from the Pleistocene epoch, with the southern peninsula composed of calcareous sands and dune limestone (Bird 1975; McGregor & Johnstone 1987; Oates & Taranto 2001). The inland study area is dominated by the Tertiary dune system, which is characterised by circular topographic features including moderate to steep slopes to an elevation of 54 m (a.s.l.) interspersed with flats and depressions to 10 m (a.s.l.) (McGregor & Johnstone 1987).

Historical vegetation structure and disturbance history of the Nepean Peninsula

At the time of European settlement much of the hinterland of the Nepean Peninsula was covered by open, grassy woodlands dominated by *Allocasuarina verticillata* (Drooping Sheoak)., *Melaleuca lanceolata* subsp. *lanceolata*, *Banksia integrifolia* subsp. *integrifolia* and *Acacia* species, along with a range of other species (Moxham *et al.* 2009*a*). Depending on topography and environmental influences some areas supported shrublands, forests, grasslands and wetlands. There were bare areas of sand, eroding cliffs, stunted vegetation dominated by low shrubs and tussock grasslands along the coastline. On the beaches *Spinifex sericeus* (Hairy Spinifex) grasslands occurred in a narrow band and sometimes shrublands of *Atriplex cinerea* (Coast Saltbush).

Prior to European settlement the Boonwurrung (Bunurong) people occupied and continually utilised the Nepean Peninsula (Spillane 1971, O'Neill 1988), influencing disturbance regimes such as fire and probable native herbivore grazing. Settlement of the area by Europeans in 1835 marked a dramatic and rapid change to new disturbance regimes, including vegetation clearance, which has shaped the vegetation associations evident today (see Moxham *et al.* 2009*a*).

The first squatting licences at Point Nepean were established in 1835 (Power *et al.* 1985) and preliminary land clearing was undertaken for pastoral runs. By the 1840s, timber harvesting and lime-burning were also taking place (Harrington 2000). *Allocasuarina verticillata* was the most useful timber species for early settlers as eucalypt species were apparently absent (Calder 1975, Moxham *et al.* 2009a). Lime-burners targeted *Allocasuarina verticillata* and possibly *Acacia uncifolia* for fuel for the kilns. The process of extracting lime from the dunes required the removal of all vegetation, disturbing the soil surface (Calder 1975). Wattles and *Leptospermum laevigatum* regenerated following these disturbances and mature wattles were stripped of their bark, which was sent to the tanneries (Calder 1972, Searle 1991). Timber was also harvested to fuel Melbourne's bakeries during the 1850s and was so scarce by 1853 that the government halted the removal of timber unless required for lime-burning (O'Neill 1988). In 1852 a quarantine station was established at Point Nepean and from 1882 to 1986 the area was used for defence force activities and training, increasing human activities and bringing novel disturbances such as bombing, the establishment of infrastructure, and mowing and slashing. Lime-burning ceased by the 1920s in the area (Hollinshed 1982). In 1988 Point Nepean became a National Park with restricted public access due to unexploded ordnance, the legacy of defence activities. Management of the vegetation also changed at this time; most of the infrastructure (tracks, buildings and cleared areas) were abandoned and some of the slashing/mowing and burning regimes ceased. Thus all vegetation on the Nepean Peninsula may be considered secondary or tertiary regeneration/regrowth following human-induced disturbances (Calder 1975). In the last 20 years there has been tenfold increase in human visitation from approximately 5,000 to 50,000 per annum in the public access area of the park (Parks Victoria 2004).

1978 sampling

In January 1978, 41 (25 m x 25 m) quadrats in selected vegetation types were sampled. In each quadrat, canopy height and projective foliage cover were recorded according to Specht (1970). Species cover/abundance was estimated using the Bridgewater scale (1971). Various environmental characteristics were recorded including landform, soil type, aspect, and any evidence of disturbance and erosion. Plots were staked in one corner and locations marked on the final vegetation map. Based on the quadrat data, field reconnaissance, aerial photography and topographic maps (1:4,800) Parr-Smith and Smith (1978) developed a map of vegetation structural formations and vegetation complexes. The complexes were three broad groups each sharing generic vegetation and environmental characteristics: (1) 'Coastal vegetation' of the foredunes, cliffs and beaches; (2) 'Scrub' vegetation of the hind dunes, and (3) areas 'Disturbed' by human activities. They also categorised the vegetation using the vegetation structural classifications of Specht and Specht (1999).

2006 sampling

In spring 2006, 62 (10 m x 10 m) quadrats were sampled. The 41 1978 plots were relocated as accurately as possible in each vegetation type though some were not able to be relocated and were substituted by quadrats placed in the general vicinity. An extra 21 quadrats were also sampled. A stratified-random point generator in GIS (Arcview Version 3.2) was used to direct quadrat positioning, with a minimum of three replicates per vegetation type. The smaller quadrat size enabled this dataset to be combined with a larger statewide data set. Some vegetation types were sampled with up to five quadrats to capture the structural variation of vegetation in the landscape. In each quadrat the following characteristics were recorded: GPS location, aspect, altitude, landscape position, evidence of disturbances, height (m) of dominant canopy species, percent live foliage cover of canopy trees, mid-storey trees, shrubs, perennial grasses, perennial forbs and weeds. The percent cover of litter, bare ground and moss was also recorded along with the length of logs > 100 mm diameter and branches < 100 mm diameter, and the presence or absence of bryophytes. All vascular plant species were identified and their percent cover recorded using a modified Braun-Blanquet scale as per Ough (2001). Plant taxonomy followed Walsh and Stajsic (2007) and structural types were determined according to Specht and Specht (1999).

The smaller quadrats sampled in 2006 compared to 1978 is likely to influence estimates of abundance and frequency of species encountered. Rare or infrequent species are less likely to be encountered in the smaller quadrats due to a smaller total survey area (2.56 ha in 1978, 0.61 ha in 2006). In considering differences in individual species frequencies between the two studies, these differences in sampling area should be taken into consideration.

Vegetation mapping

Current (2006) vegetation was mapped using GIS layers obtained from the Victorian Department of Sustainability and Environment Corporate Geospatial Data Library. These included aerial photography (Melbourne 2005 image), topography and extant Ecological Vegetation Classes (EVC, Oates & Taranto 2001). The Ecological Vegetation Class (EVC) is a classification system higher than the floristic community level (Parkes *et al.* 2003) and was the main vegetation unit used in the collection of data in 2006. The EVC is defined by both floristic and structural attributes, as well as ecological processes that may be characteristic of its environment (Woodgate *et al.* 1996). For comparison with the 1978 data set, the structural types in each EVC were classified according to the system of Specht and Specht (1999) and assigned to a structural formation or a vegetation complex.

The Parr-Smith and Smith (1978) vegetation map was digitised and geo-rectified. The 1978 map and extant EVC maps were then combined to produce a rough layer of vegetation types to stratify the landscape for the field survey. EVC boundaries were refined during this study using aerial photography and the new quadrat data collected in each vegetation type. This was then digitised to produce a final layer of vegetation types.

The overall changes in the area (ha) covered by the different vegetation groups are represented graphically. Differences in species and lifeform frequency between 1978 and 2006 were compared by the non-parametric Wilcoxon signed-rank pairs test, as normality could not be improved (Kent & Coker 1992).

Results

Vegetation description – 2006

Detailed descriptions of the vegetation, associated structural attributes, landscape position and characteristic species (following Oates & Taranto 2001, Moxham *et. al.* 2009*a*) described in the 2006 survey are provided below (also see Table 1).

Coastal Alkaline Scrub (EVC 858) dominates the hind dune system (scrub complex). Variable in structure ranging from a woodland or shrubland to closed scrub. Dominant canopy species include *Leptospermum laevigatum* (Coast Tea-tree), *Melaleuca lanceolata* subsp. *lanceolata* (Moonah), *Leucopogon parviflorus* (Coast Beard-heath) and *Allocasuarina verticillata* (Drooping She-oak) (Oates & Taranto 2001). Coastal Moonah Woodland (listed as threatened under the *Victorian Flora and Fauna Guarantee Act* 1988) is one of several floristic communities belonging to this EVC (DSE 2002, Moxham *et. al.* 2009*b*); the study area contains the largest continuous stand of this community in the region.

On the hind dune swales and flats occurs an un-resolved unit (referred to as **Calcareous Swale Grassland** (EVC 309)). The grassy ground layer is dominated by *Poa labillardieri* (Common Tussock-grass) and the canopy, when present, is composed of *Banksia integrifolia* subsp. *integrifolia* (Coast Banksia).

In exposed situations on upper slopes and crests of secondary dunes along the southern coastline, **Coastal Dune Scrub** (EVC 160) forms a low closed shrubland. It is dominated by *Acacia longifolia* var. *sophorae* (Coast Wattle), *Leptospermum laevigatum* (Coast Tea-tree) and sometimes, by stunted *Melaleuca lanceolata* subsp. *lanceolata* (Moonah).

In the coastal complex, on the exposed primary dunes and headlands **Coastal Headland Scrub** (EVC 161) and **Spray-zone Coastal Shrubland** (EVC 876) form wind-pruned shrublands. Dominant species include *Correa alba* (Coast Correa) and *Leucophyta brownii* (Cushion Bush). **Coastal Tussock Grassland** (EVC 163) also occurs on the exposed cliffs with the grass *Austrostipa stipoides* (Prickly Spear-grass) prominent. **Coastal Dune Grassland** (EVC 879) is found on the siliceous sandy beaches of the more protected Bay side. It is dominated by *Spinifex sericeus* (Hairy Spinifex). **Berm Grassy Shrubland** (EVC 311) occurs on sand deposits formed by low wave action on the sheltered bay beaches. It is composed of low succulent shrubs such as *Atriplex cinerea* (Coast Saltbush), over a ground layer of grasses and herbs.

Table 1. Alignment of the vegetation classifications at Point Nepean used by Parr-Smith and Smith (1978), the Vegetation Complexes and Vegetation structural formations (as per Parr-Smith and Smith 1978), with Ecological Vegetation Classes, landscape positions and dominant characteristic species (Parr-Smith & Smith 1978, Oates & Taranto 2001)

Vegetation complex	Vegetation structural formation	Ecological vegetation class (EVC)	Landscape position	Dominant characteristic species
Coastal complex (3)	Grassland (2b)	Coastal tussock grassland (163)	Exposed coastal cliffs	*Austrostipa stipoides*
	Coastal scrub (3a)	Coastal dune scrub (160)	Exposed crests & slopes of secondary dunes	*Leucopogon parviflorus, Acacia longifolia* var. *sophorae, Leptospermum laevigatum, Melaleuca lanceolata* subsp. *lanceolata*
	Heath (3b)	Coastal headland scrub (161)	Exposed parts of the coast	*Leptospermum laevigatum, Leucopogon parviflorus, Pimelea serpyllifolia* subsp. *serpyllifolia, Correa alba, Leucophyta brownii*
	Coastal cliffs (3c)	Spray-zone coastal shrubland (876)	Exposed parts of the coast	As Above
	Fore dune (3d)	Berm grassy shrubland (311)	Fore dune	*Atriplex cinerea*
	Fore dune (3d)	Coastal dune grassland (879)	Fore dune:	*Spinifex sericeus, Ammophila arenaria, Cakile maritima*
	Beach/ cliff/ blowout (3d–g)	Beach/cliff (999)	Beach, Cliff, Blowout	N/A
Disturbed complex (2)	Scrub grassland (2a)	Disturbed and exotic vegetation (998)	All	Dominated by exotic species (namely *Stenotaphrum secundatum* and *Polygala myrtifolia var. myrtifolia*) and/or *Leptospermum laevigatum, Melaleuca lanceolata* subsp. *lanceolata, Poa labillardierei, Lepidosperma gladiatum*
	Denuded (2c)	Disturbed areas/ infrastructure (997)	All	N/A
Scrub complex (1)	Scrub complex (1)	Coastal alkaline scrub (858)	Sheltered secondary dunes & hind dunes	*Leptospermum laevigatum, Melaleuca lanceolata* subsp. *lanceolata, Leucopogon parviflorus, Acacia uncifolia, Allocasuarina verticillata, Bursaria spinosa* subsp. *macrophylla, Hibbertia sericea, Adriana quadripartita, Poa labillardierei, Pimelea serpyllifolia* subsp. *serpyllifolia, Rhagodia candolleana* subsp. *candolleana, Alyxia buxifolia, Tetragonia implexicoma, Dichondra repens, Swainsona lessertiifolia*
	Grassland (2b)	Calcareous swale grassland (309)	Swales & flats of hind dunes	*Poa labillardieri*

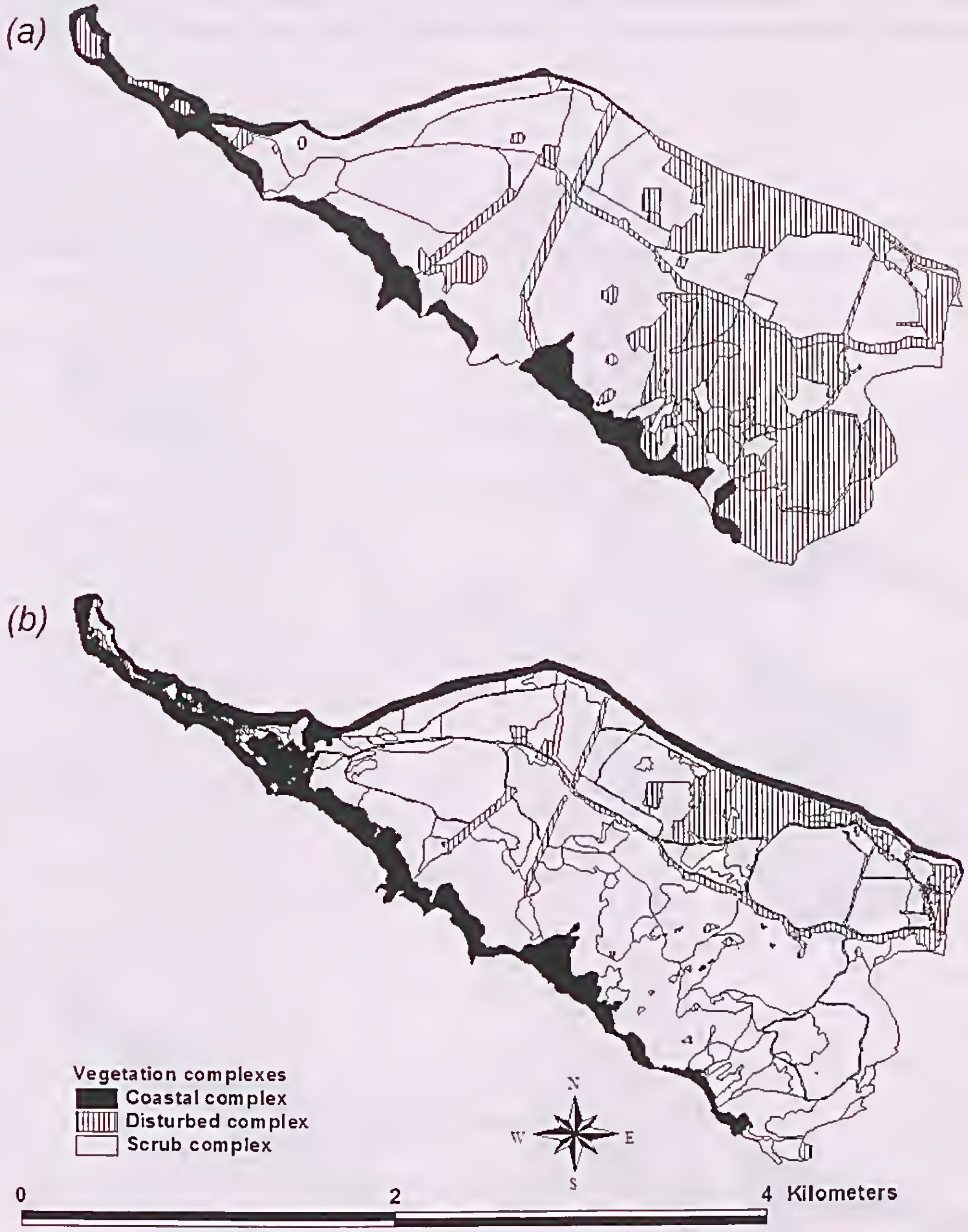

Fig. 1. The study area at Point Nepean, displaying broad vegetation groups (Vegetation Complexes) in (*a*) 1978 and (*b*) 2006.

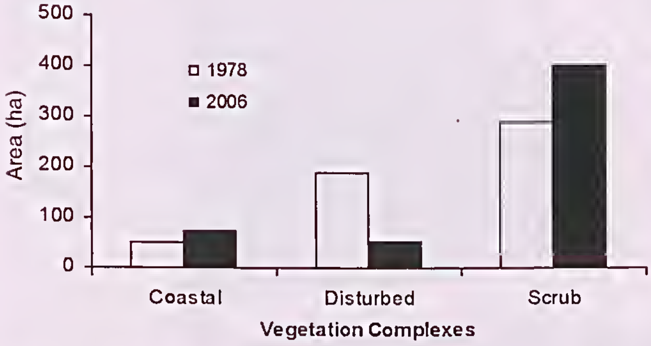

Fig. 2. Total area (ha) of broad vegetation complexes (coastal, disturbed and scrub) at Point Nepean in 1978 and 2006.

Table 2. Results of the Wilcoxon matched-pairs test (two sided). Significant results (*P* 0.001) are mark with an *

Lifeform	***P*-value**	**Sample size**
Total	0.001*	173
Native	0.001*	107
Exotic	0.001*	66
Small trees	0.018*	10
Shrubs	0.068	27
Herbs	0.001*	90
Grasses	0.001*	46

Table 3. Percent frequency of species recorded in vegetation in Point Nepean National Park in 1978 (41 quadrats) and 2006 (6 quadrats). Species are listed in lifeform groups. Frequency is estimated using presence data where frequency is defined as th number of occurrences divided by the total number of quadrats sampled for that year). * Denotes exotic species.

	1978	2006
Small trees		
Acacia longifolia subsp. *sophorae*	0	3
Acacia mearnsii	0	5
Acacia uncifolia	12	47
Allocasuarina verticillata	0	2
Banksia integrifolia subsp. *integrifolia*	0	13
Bursaria spinosa subsp. *spinosa*	0	2
Leptospermum laevigatum	54	77
Leucopogon parviflorus	54	65
Melaleuca lanceolata subsp. *lanceolata*	41	35
Pittosporum undulatam	0	8
Shrubs		
Adriana quadripartita	5	2
Alyxia buxifolia	10	44
Atriplex cinerea	15	6
Cakile maritima subsp. *maritima*	5	5
Correa alba	10	11
Correa reflexa	0	3
Dodonaea viscosa subsp. *spatulata*	0	3
Hibbertia sericea s.l.	5	26
Leucophyta brawnii	17	10
Muehlenbeckia adpressa	7	3
Olearia axillaris	12	29
Olearia glutinosa	7	3
Olearia sp. 2	0	2
Pimelea serpyllifolia subsp. *serpyllifalia*	68	52
Pomaderris paniculosa subsp. *paralia*	15	15
Pultenaea canaliculata	0	2
Pultenaea tenuifolia	0	13
Rhagodia candolleana subsp. *candolleana*	54	60
Tetragonia implexicoma	54	42
Tetragonia tetragonioides	0	2
**Chrysanthemoides monilifera*	0	19
**Conyza* sp.	0	15
**Coprosma repens*	0	2
**Lycium ferocissimum*	0	2
**Myoporum insulare*	2	6
**Polygala myrtifolia* var. *myrtifolia*	22	63
**Rhamnus alaternus*	0	37
Woody parasites		
Amyema miquelii	0	5
Amyema pendula	0	5
Amyema preissii	0	10
Herbs		
Dianella brevicaulis	0	35
Dianella revoluta s.l.	7	3
Acaena novae-zelandiae	0	5
Actites megalocarpa	0	11
Ajuga australis	0	10
Apalochlamys spectabilis	7	0
Apium prostratum subsp. *prostratum*	7	11
Caladenia latifolia	0	5
Carpobrotus rosii	27	15
Cassytha pubescens s.s.	7	2
Clematis microphylla	46	60
Comesperma volubile	10	6
Convolvulus erubescens ssp. *agg.*	0	24
Corybas sp.	0	5
Crassula peduncularis	0	3
Crassula sieberiana	0	15
Cynoglossum australe	0	19
Cyrtostylis sp.	0	2
Daucus glochidiatus	7	45
Dichondra repens	51	63
Dipogan lignosus	0	2
Disphyma crassifolium subsp. *clavellatum*	0	2
Euchiton sp.	0	2
Galium sp.	10	16
Helichrysum leucopsideum	7	3
Hydracotyle laxiflora	7	40
Kennedia prostrata	5	10
Lagenophora stipitata	27	19
Luzula sp.	0	2
Microtis sp.	0	2
Oxalis sp.	5	21
Ozothamnus turbinatus	0	3
Parietaria debilis	0	5
Pelargonium australe	2	2
Pterostylis cucullata	0	2
Sarcocornia sp	0	2
Scaevola albida	0	8
Senecio odoratus var. *odoratus*	27	56
Senecia sp.	5	2
Senecio spathulatus	0	8
Stackhousia monogyna	0	2
Swainsona lessertiifolia	39	58
Thinopyrum junceiforme	12	16
Threlkeldia diffusa	15	24
Thuidiopsis furfurosa	0	16
Viola hederacea	0	6
Viola sp.	0	2
Wurmbea latifalia	0	11
Zygophyllum billardierei	5	10
**Anagallis arvensis*	24	21
**Anchusa arvensis*	0	3
**Asparagus asparagoides*	12	48
**Asparagus scandens*	0	3
**Cakile* sp	0	5
**Carduus tenuiflorus*	0	2
**Centaurium* sp.	0	29
**Cerastium glomeratum*	17	6
**Cerastium* sp.	0	34
**Cirsium vulgare*	0	3
**Dolichos lignosus*	5	0
**Euphorbia peplus*	0	5
**Fumaria muralis* subsp. *muralis*	0	2
**Hypochoeris glabra*	0	23
**Hypochoeris radicata*	12	6
**Hypoxis glabella*	0	2
**Leontodon taraxacoides*	0	3
**Lotus* sp.	0	2
**Malva dendromorpha*	0	2
**Malva* sp.	0	2
**Medicago* sp.	0	2
**Melilotus indicus*	0	3
**Minuartia mediterranea*	0	24
**Orobanche minor*	0	5
**Parapholis incurva*	0	2
**Petrorhagia dubia*	0	5
* *Petrorhagia* sp.	0	2
**Plantago lanceolata*	0	3
**Polycarpon tetraphyllum*	0	2
**Romulea* sp.	0	2
**Senecio elegans*	20	11
**Sherardia arvensis*	0	2
**Silene nacturna*	0	13
**Silene vulgaris*	0	2
**Sonchus oleraceus*	7	10
**Stellaria angustifolia*	0	2
**Trifolium dubium*	0	3
**Vinca major*	0	2
Grasses and sedges		
Austrodanthonia caespitosa	0	2
Austrodanthonia sp.	0	61
Austrostipa flavescens	24	58
Austrostipa stipoides	10	5
Carex breviculmis	17	21
Cynodon dactylon	5	0
Dichelachne crinita	7	5
Diplotaxis tenuifolia	0	5
Distichlis distichophylla	0	3
Elymus scaber	15	19
Ficinia nodosa	20	29
Lachnagrostis billardierei s.l.	24	21
Lepidosperma gladiatum	32	58
Lomandra longifolia	0	6
Poa ensiformis	0	5
Poa labillardierei	56	61
Poa labillardierei var. *labillardierei*	0	3
Poa morrisii	0	2
Poa poiformis	27	5
Poa poiformis var. *ramifer*	0	15
Poa rodwayi	0	5
Poa sp.	0	2
Schoenus nitens	20	3
Spinifex sericeus	10	6
Themeda triandra	0	6
**Aira* sp.	34	52
**Ammophila arenaria*	10	5
*Avena sp.	0	11
**Briza minor*	0	10
**Bromus diandrus*	7	10
**Bromus hordeaceus* subsp. *hordeaceus*	0	2
**Bromus* sp	0	10
**Catapodium rigidum*	29	53
**Ehrharta longiflora*	0	8
**Ehrharta erecta* var. *erecta*	0	18
**Holcus lanatus*	0	2
**Lagurus ovatus*	41	39
**Pennisetum clandestinum*	0	3
**Phalaris* sp.	0	3
**Psilurus incurvus*	0	5
**Rostraria crista*	0	27
**Sporobolus africanus*	0	11
**Stenataphrum secundatum*	10	13
**Vulpia ciliata*	7	0
**Vulpia myuras*	17	56

Vegetation description – 1978

Parr-Smith and Smith (1978) describe the hinterland vegetation of Point Nepean as predominately dune 'Scrub' dominated by *Leptospermum laevigatum* and *Melaleuca lanceolata* subsp. *lanceolata* (Table 1). The dune 'Scrub' is interlaced with areas of *Poa labillardierei* grasslands and exotic grasslands, as a result of vegetation clearance. Different vegetation sub-units occur in the dune 'Scrub' as fine scale mosaics, with subtle changes in species dominance and structural characteristics ranging from shrublands through to woodlands and low open forests. In the 'Coastal' complex wind-pruned heath communities composed of *Leucophyta brownie* and *Correa alba* occur on exposed coastal areas; interlaced with coastal cliff communities of *Austrostipa stipoides* grasslands. With wind-pruned heaths of *Leptospermum laevigatum*, *Leucopogon parviflorus* and *Pimelea serpyllifolia* occur on the dunes. On the protected bay-side dunes a coastal scrub dominated by *Leucopogon parviflorus* occurs. In some places on the protected foredunes *Spinifex sericeus* grasslands *and Atriplex cinerea* shrublands occur.

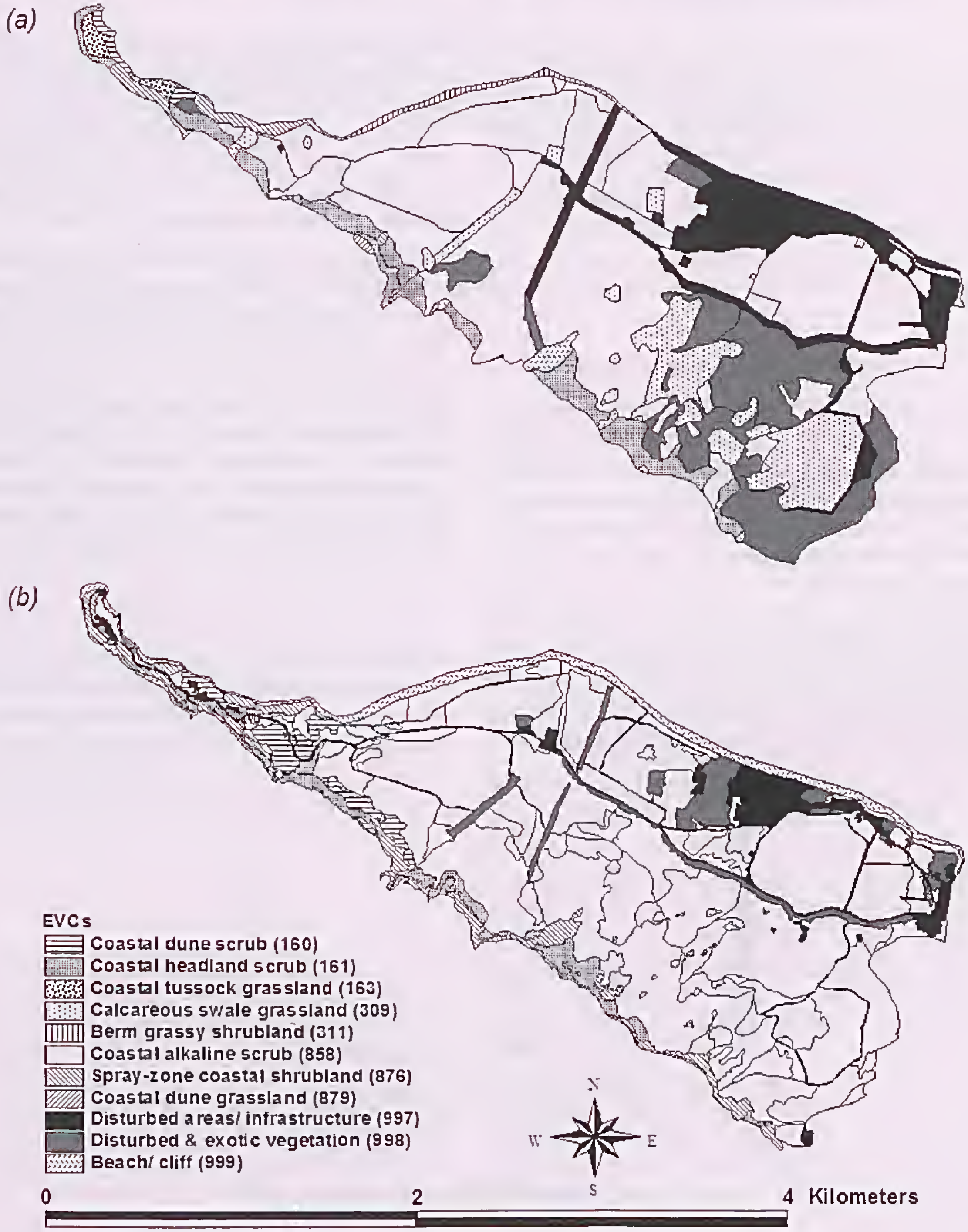
(a)
(b)
EVCs
Coastal dune scrub (160)
Coastal headland scrub (161)
Coastal tussock grassland (163)
Calcareous swale grassland (309)
Berm grassy shrubland (311)
Coastal alkaline scrub (858)
Spray-zone coastal shrubland (876)
Coastal dune grassland (879)
Disturbed areas/ infrastructure (997)
Disturbed & exotic vegetation (998)
Beach/ cliff (999)
N
W
E
S
0
2
4 Kilometers

Fig. 3. The study area at Point Nepean, displaying Ecological Vegetation Classes (EVCs) in (*a*) 1978 and (*b*) 2006.

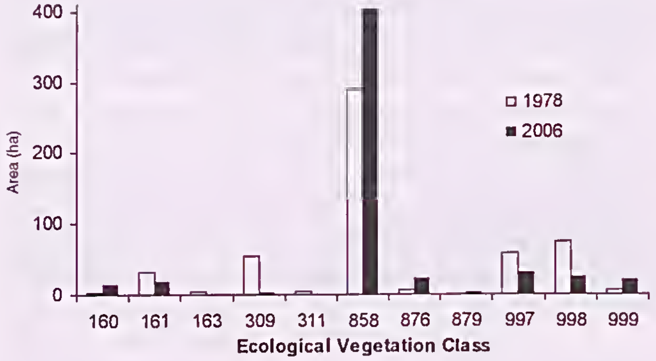

Fig. 4. Total area (ha) of Ecological Vegetation Classes in 1978 and 2006 at Point Nepean. Coastal Dune Scrub (160), Coastal Headland Scrub (161), Coastal Tussock Grassland (163), Calcareous Swale Grassland (309), Berm Grassy Shrubland (311), Coastal Alkaline Scrub (858), Spray-zone Coastal Shrubland (876), Coastal Dune Grassland (879), Disturbed Areas including infrastructure (997), Disturbed and Exotic Vegetation (998) and Beach/cliff/blowout (999).

Changes in vegetation structure between 1978 and 2006.

The majority of vegetation change at Point Nepean since 1978 has occurred in the hind dune system. Between 1978 and 2006 the area of disturbed vegetation and ruined infrastructure decreased by 135 ha (25%) as a result of increases in the area of scrub complex (55% increase, 113 ha) and a slight increase in the coastal complex (4% increase, 22 ha) (Table 1, Figs. 1 and 2).

The Ecological Vegetation Class Coastal Alkaline Scrub (EVC 858) covered the majority of the park in both 1978 and 2006 and increased by 21% (112 ha) between 1978 and 2006 (Figs. 3 and 4). The observed increase was due to invasion by woody species such as *Leptospermum laevigatum,* into grassland areas within the hind dune system. Spray-zone Coastal Shrubland (EVC 876) and Coastal Dune Scrub (EVC 160) also increased between 1978 and 2006 but Grassy vegetation (Coastal Tussock Grassland EVC 163 and Calcareous Swale Grassland EVC 309) was almost absent in 2006 largely due to replacement by Coastal Alkaline Scrub. These changes are reflected in the vegetation structural formations, devised by Parr-Smith and Smith (1978), with an increase in shrubland associations (Fig. 5) and a decrease in grasslands and the shrubland/grassland interface by 2006.

Floristic changes

Despite a much smaller total sampling area, 168 plant species were recorded in the 2006 quadrats compared to 135 in 1978. A total of 273 species (157 native, 116 exotic) were recorded throughout the survey area in 2006 i.e. in quadrats and observed (63% of species recorded in the 2006 quadrats were native compared with 54% in 1978). Exotic species recorded in the quadrats slightly increased from 62 in 1978 to 65 in 2006.

The frequency of several native woody species increased between 1978 and 2006, including *Leptospermum laevigatum, Acacia uncifolia* and *Alyxia buxifolia* (Sea Box) (Tables 2 and 3, Fig. 6). Exotic species that have increased include grasses and herbaceous species such as *Aira sp., Asparagus asparagoides* (Bridal Creeper), *Catapodium rigidum* (Fern Grass), and the highly invasive woody weeds *Polygala myrtifolia* var. *myrtifolia* (Myrtle-leaf Milkwort), *Chrysanthemoides monilifera* (Boneseed) and *Rhamnus alaternus* (Italian Boxthorn). This generic increase in woody invasive species occurred predominately in the hind dune system.

Changes in the hind dunes species

A number of characteristic native species of the hind dune scrub complex (see Table 1) changed in frequency. There were increases in the groundlayer species *Swainsona lessertiifolia* (Coast Swainson-pea), *Dichondra repens*

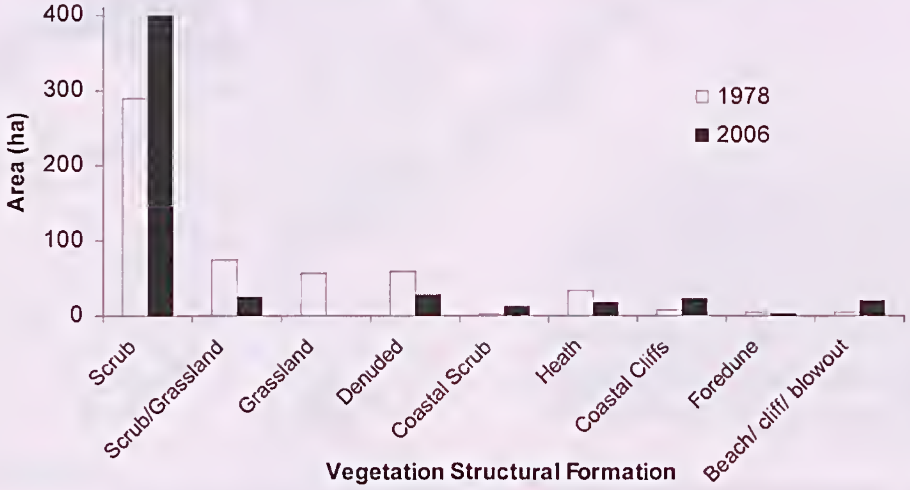

Fig. 5. Total area (ha) of vegetation structural formations (Parr-Smith & Smith 1978) in 1978 and 2006 at Point Nepean.

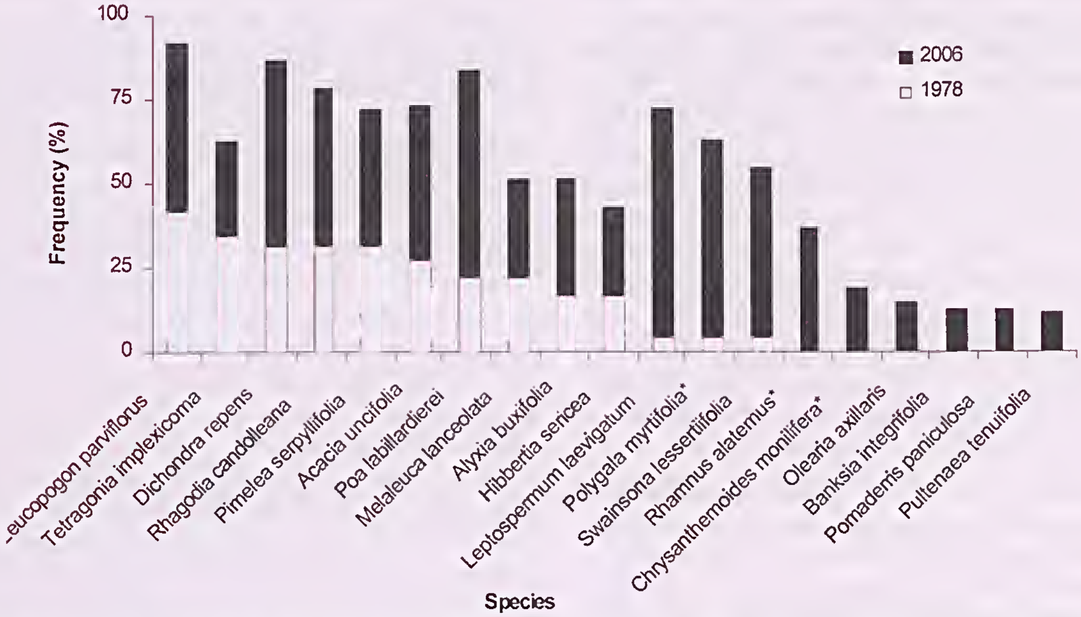

Fig.6. Percent frequency (stacked) of characteristic native species and dominant woody species recorded in vegetation quadrats, in the hind dune shrubland associations (i.e. Coastal Alkaline Scrub/Scrub complex) in 1978 and 2006 at Point Nepean. Characteristic species as per Parr-Smith & Smith (1978) and Oates & Taranto (2001).

(Kidney Weed), *Rhagodia candolleana* subsp. *candolleana* (Sea-berry Saltbush) and interestingly *Poa labillardieri* and the native woody species *Leptospermum laevigatum* and *Acacia uncifolia* (Fig. 6). In 1978 the dominant woody species of the hind dune system were *Melaleuca lanceolata* subsp. *lanceolata*, *Leucopogon parviflorus*, *Pimelea serpyllifolia* subsp. *serpyllifolia* (Thyme Rice-flower) and *Acacia uncifolia* (Fig. 6). While *Melaleuca lanceolata* subsp. *lanceolata*, *Acacia uncifolia*, *Leucopogon parviflorus* and *Pimelea serpyllifolia* subsp. *serpyllifolia* were still prevalent in 2006, particularly in least disturbed areas where they formed low woodlands, *Leptospermum laevigatum* and the exotic *Polygala myrtifolia* var. *myrtifolia* also occurred at a high frequency. The exotic woody species *Rhamnus alaternus* and *Chrysanthemoides monilifera* were also more widespread in the hind dune system in 2006 (Fig. 6).

Discussion

In the 28 years between 1978 and 2006 broad scale changes in the vegetation of Point Nepean have occurred. The coastal vegetation of the foredunes, cliffs and blowouts has increased slightly, perhaps indicating primary succession, and secondary succession of disturbed areas, but the major change has been the widespread shrubland invasion of the hind dune system. This change is predominately reflected in the invasion of taller woody species into native and exotic grasslands and disturbed areas. Invasive woody species include both native species characteristic of this zone and exotic woody species that have increased in areas that were previously, grasslands, disturbed vegetation or ruined/abandoned infrastructure.

The removal of disturbance regimes such as burning and grazing have been frequently reported to trigger the invasion of woody species (Kirkpatrick 1975, van der Maarel *et al.* 1985, Molnar *et al.* 1989, Offor 1990, Bennett 1994, McMahon *et al.* 1996, Lunt 1998, Costello *et al.* 2000, Zbigniew and Stefania 2007), and our study supports this. Native woody species (e.g. *Alyxia buxifolia*) increased on the more exposed hind dunes, and *Leptospermum laevigatum* increased in abundance to form shrublands on the protected hind dune system. Exotic woody invasive species such as *Polygala myrtifolia* var. *myrtifolia* have also increased in these systems, particularly in the hind dune and the area covered by grasslands (Parr-Smith & Smith 1978) has declined.

Bennett (1994) studied changes in coastal vegetation at Wilsons Promontory south-east of Point Nepean over a 50 year period and highlighted the expansion of *Leptospermum laevigatum* into both coastal secondary grasslands and *Banksia* woodlands. This expansion coincided with changes in human-induced disturbance regimes, the halting of burning, removal of cattle and an increase in grazing pressure by kangaroos and rabbits. This change in grazing regime led to an increase in woody species encroachment due to cessation of cattle browsing on shrubs and the creation of bare ground for seedling establishment (Bennett 1994). At Point Nepean grazing is low due to the exclusion of exotic herbivores (as much as reasonably practicable) and lack of native herbivores in the park. The major changes in disturbance regimes in recent years have been (1) the change in burning and slashing/mowing regimes in some locations, (2) the removal of human disturbances brought about by the halting of defence activities and (3) the increase in human traffic in some areas of the park. As neither domestic stock nor large native herbivores have used the area since the late 1800s (O'Neill 1988) it is likely that the change in burning, slashing/mowing regimes and other human activities that have occurred in different areas of the park underlie the recent expansion of woody species. Conversely, the process of invasion by woody species may have begun at a much earlier stage. There is anecdotal historical information suggesting invasion by *Leptospermum laevigatum* began much earlier and the beginning of it may well date back to the late 19th century (Moxham *et al.* 2009*a*).

In a previous study (Moxham *et al.* 2009*a*) we examined the historical accounts of vegetation of the Nepean Peninsula and highlighted the changing hind dune system from woodlands to *Leptospermum laevigatum* scrublands with the arrival of European land use and changes to disturbance regimes. It is thought that *Leptospermum laevigatum* communities were once restricted to a narrow band along the coast (Moxham *et al.* 2009*a*), indicating that this species may be a relatively recent component of the hind dune vegetation. *Leptospermum laevigatum* is a vigorous colonising species (Burrell 1981; Offor 1990; Bennett 1994), competitively excluding other species that inhabit similar niches, such as *Melaleuca lanceolata* subsp. *lanceolata* and *Leucopogon parviflorus*. *Melaleuca lanceolata* subsp. *lanceolata* and *Leucopogon parviflorus* have remained relatively stable in frequency at Point Nepean since 1978 and vegetation dominated by these species occurs in areas that have had the least disturbance (Moxham *et al.* 2009*a*). However, the composition and thus structure of these hind dune communities appears to have changed with the increase in frequency of *Leptospermum laevigatum* and *Polygala myrtifolia* var. *myrtifolia*. Given the probable historical distribution of *Leptospermum laevigatum* (see below, Moxham *et al.* 2009*a*) these results indicate that the current hind dune vegetation may be forming new communities in this landscape. Indeed at a statewide level Lunt *et al.* (2010) indicate that changes brought about by woody plant invasion in coastal systems may reflect a more enduring longer-term process.

The management of vegetation with a history of varied and intensive disturbances in an urban landscape context provides challenges. What should be the objective of management and what vegetation types or transitional phases are desired? The various vegetation structures of Point Nepean reflect past and present disturbance underlying physical processes. The hind dune landscapes vary in structure and include small areas of grasslands and low woodlands and more extensive areas of shrublands. Some of these vegetation communities are now rare in the landscape and have high conservation value (e.g. Coastal Moonah Woodland, calcareous swale grassland). Historically these hinterland areas may have been covered with woodlands and forests (Moxham *et al.* 2009*a*) but the changes since 1978 demonstrate an increasing cover of shrublands, a pattern that we expect to continue. Should we be actively managing to encourage development of the historical vegetation (e.g. open woodlands of *Allocasuarina verticillata*, *Melaleuca lanceolata* subsp. *lanceolata*, *Banksia. integrifolia* subsp. *integrifolia* and *Acacia* species), or manage the current composition to maintain the existing species and structure? A primary management aim might be to maintain the existing native species diversity in the National Park for the long-term. This could be undertaken by examining the interaction between the less common species and their habitat structure to prioritise management zones and strategies. Indeed the mosaic of coastal vegetation types representing a complete system is now becoming scarce due to increasingly urbanised landscapes and Point Nepean represents one of the last remaining examples of this complete coastal dune ecosystem (fore dune and hind dune system) in the region. However, as this area now occurs in a relatively densely-populated urban landscape, practical considerations such as potential fire hazards as well as human preference must influence the decision making process. The inherent dynamic nature of the shrublands dominated by *Leptospermum laevigatum* must also be considered as this will affect the resources required to direct or maintain vegetation structure and composition.

In summary, there has been widespread change in the coastal vegetation at Point Nepean, particularly in the hind dune landscape following the removal of human-induced disturbances. Areas of disturbed vegetation (including exotic and disturbed native vegetation), ruined/abandoned infrastructure, exposed coastal sites (such as blowouts, dunes and cliffs) and grasslands have decreased while scrub communities have increased. The increase in shrublands may have begun before the 1978 Parr-Smith and Smith survey. The coastal system is highly dynamic. Various vegetation states are evident and National Park management actions will depend on which state is desired and the location in the coastal landscape (e.g. swale, tertiary dune etc).

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New South Wales Vegetation classification and Assessment: Part 3 Plant communities of the NSW Brigalow Belt South, Nandewar and west New England Bioregions and update of NSW Western Plains and South-western Slopes plant communities, Version 3 of the NSWVCA database

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Abstract: This fourth paper in the NSW Vegetation Classification and Assessment series covers the Brigalow Belt South (BBS) and Nandewar (NAN) Bioregions and the western half of the New England Bioregion (NET), an area of 9.3 million hectares being 11.6% of NSW. It completes the NSWVCA coverage for the Border Rivers-Gwydir and Namoi CMA areas and records plant communities in the Central West and Hunter–Central Rivers CMA areas. In total, 585 plant communities are now classified in the NSWVCA covering 11.5 of the 18 Bioregions in NSW (78% of the State). Of these 226 communities are in the NSW Western Plains and 416 are in the NSW Western Slopes. 315 plant communities are classified in the BBS, NAN and west-NET Bioregions including 267 new descriptions since Version 2 was published in 2008. Descriptions of the 315 communities are provided in a 919 page report on the DVD accompanying this paper along with updated reports on other inland NSW bioregions and nine Catchment Management Authority areas fully or partly classified in the NSWVCA to date. A read-only version of Version 3 of the NSWVCA database is on the DVD for use on personal computers. A feature of the BBS and NAN Bioregions is the array of ironbark and bloodwood *Eucalyptus*-dominated shrubby woodlands on sandstone and acid volcanic substrates extending from Dubbo to Queensland. This includes iconic natural areas such as Warrumbungle and Mount Kaputar National Parks and the 500,000 ha Pilliga Scrub forests. Large expanses of basalt-derived soils support grassy box woodland and native grasslands including those on the Liverpool Plains; near Moree; and around Inverell, most of which are cleared and threatened. Wetlands occur on sodic soils near Yetman and in large clay gilgais in the Pilliga region. Sedgelands are rare but occupy impeded creeks. Aeolian lunettes occur at Narran Lake and near Gilgandra. Areas of deep sand contain *Allocasuarina*, eucalypt mallee and *Melaleuca uncinata* heath. Tall grassy or ferny open forests occur on mountain ranges above 1000m elevation in the New England Bioregion and on the Liverpool Range while grassy box woodlands occupy lower elevations with lower rainfall and higher temperatures. The vegetation classification and assessment is based on over 100 published and unpublished vegetation surveys and map unit descriptions, expert advice, extra plot sampling and data analysis and over 25 000 km of road traverse with field checking at 805 sites. Key sources of data included floristic analyses produced in western regional forest assessments in the BBS and NAN Bioregions, floristic analyses in over 60 surveys of conservation reserves and analysis of plot data in the western NET Bioregion and covering parts of the Namoi and Border Rivers-Gwydir CMA areas. Approximately 60% of the woody native vegetation in the study area has been cleared resulting in large areas of "derived" native grasslands. As of June 2010, 7% of the area was in 136 protected areas and 127 of the 315 plant communities were assessed to be adequately protected in reserves. Using the NSWVCA database threat criteria, 15 plant communities were assessed as being Critically Endangered, 59 Endangered, 60 Vulnerable, 99 Near Threatened and 82 Least Concern. 61 of these communities are assessed as part of NSW or Commonwealth-listed Threatened Ecological Communities. Current threats include expanding dryland and irrigated cropping on alluvial plains, floodplains and gently undulating topography at lower elevations; over-grazing of steep hills; altered water tables and flooding regimes; localised mining; and the spread of exotic species, notably Coolatai Grass (*Hyparrhenia hirta*).

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Introduction

This is the fourth paper in the New South Wales Vegetation Classification and Assessment project (NSWVCA) that aims to finely classify and assess the status of plant communities in New South Wales (NSW). The progression of the NSWVCA is mainly based on classifying and assessing vegetation across the 18 bioregions in NSW based on their definition in version 6.1 of the Interim Biogeographic Regionalisation for Australia (Thackway & Cresswell 1995). NSW Catchment Management Authority Areas are being covered as part of this process.

The paper and its accompanying DVD contains Version 3 of the NSWVCA database and provides a detailed classification and assessment of the native vegetation in the New South Wales sections of the Brigalow Belt South (BBS) and Nandewar (NAN) and the western half of the New England Tableland Bioregion (west-NET) (Figure 1) (version 6.1 of Thackway & Cresswell 1995). The completion of the BBS and NAN Bioregions, in addition to the previously classified NSW South-western Slopes Bioregion (NSWSWS) in Benson (2008), means that the NSWVCA now covers the NSW Western Slopes Section (shown in Fig. 8, page 336, Benson 2006). The coverage of the New England Tableland Bioregion west of the Great Dividing Range aims to complete the NSWVCA for the whole of the Border Rivers-Gwydir and Namoi Catchment Management Authority (CMA) areas and initiate coverage of the NSW Tablelands Section (shown in Fig 8, page 336, Benson 2006). As discussed in Benson (2006), CMA areas are quite different in their configuration compared to the IBRA bioregions, yet environmental assessment in NSW under various regulations is orientated towards CMAs rather than IBRA bioregions.

The first paper published in the NSWVCA series (Benson 2006) contained a history and description of vegetation classification internationally, in Australia and in NSW; descriptions of the parameters of the NSWVCA project; descriptions of the NSWVCA database fields, reports and software; descriptions of the protected area assessment rules and threat criteria used to assign protected area adequacy and threat categories to the classified plant communities. Benson (2006) includes a number of figures showing planning regions in NSW, including bioregions and CMAs. These figures should be referred to when reading this paper.

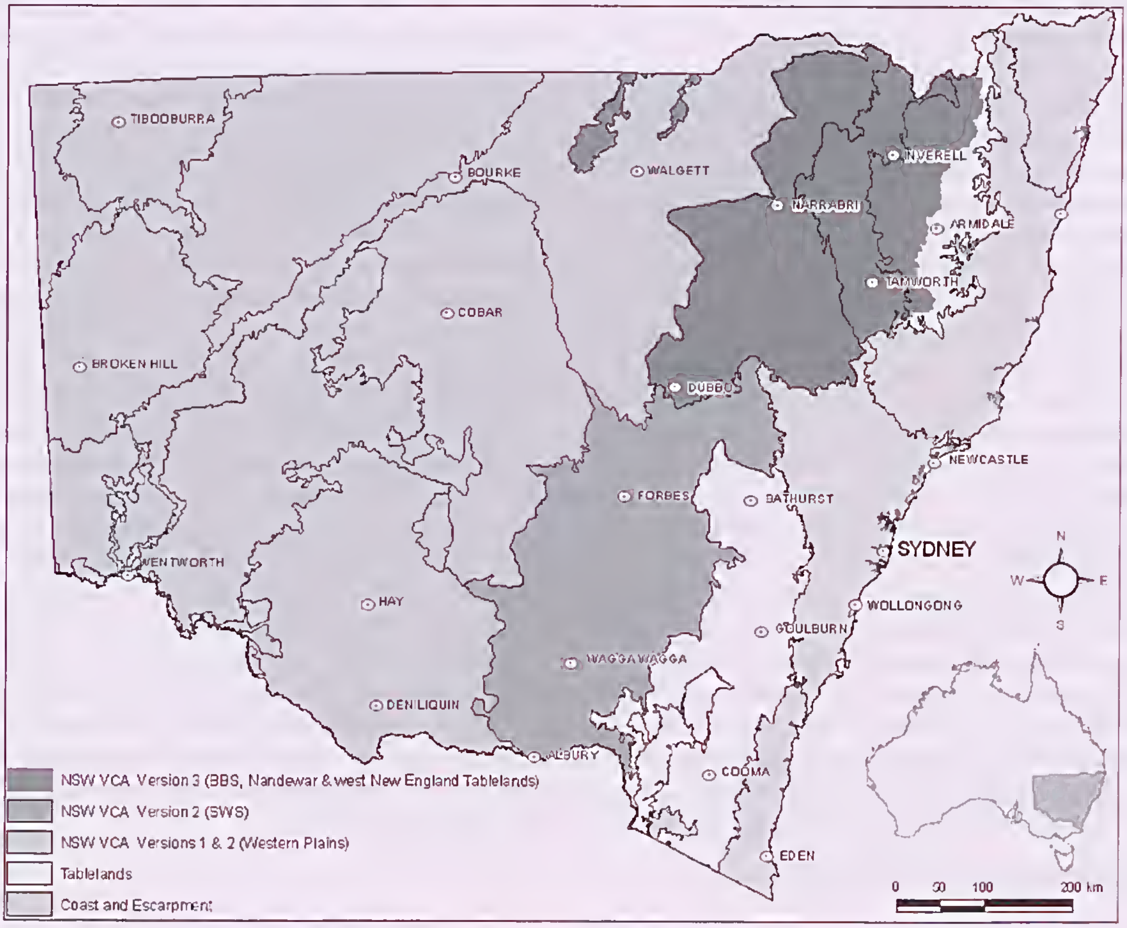

Fig. 1. Progress of the NSWVCA project across New South Wales, Australia. Version 1 (Benson *et al.* 2006) covered the NSW Western Plains. Version 2 covered the NSW South-western Slopes Bioregion Benson 2008). Version 3 updates the NSWVCA for the NSW Western Plains and NSW South-western Slopes and includes extra plant communities occurring in the BBS, NAN and west-NET Bioregions (this volume). Version 4 is proposed to add the South East Highlands and Australian Alps Bioregions to the NSWVCA.

The second NSWVCA paper (Benson *et al.* 2006), contained Version 1 of the NSWVCA database with 213 plant communities (updated to 226) classified and described for the eight western-most NSW IBRA bioregions that comprise the semi-arid and arid NSW Western Plains (57% of NSW) (see Table 1 and Figure 2 in Benson 2006). The third NSWVCA paper (Benson 2008), contained Version 2 of the NSWVCA database, added 97 communities to Version 1 and described 135 plant communities (updated to 146) in the eight million hectare NSW South-western Slopes Bioregion. Paper 4 (this volume) adds NSWVCA coverage of the vegetation in the 9.3 million hectare BBS, NAN and western NET Bioregions. This means that 63 million hectares or 78% of NSW (Figure 1) have been now covered by a detailed vegetation classification and plant community status assessment.

As outlined in the three previous NSWVCA papers, the project builds on the Australian vegetation classification of Beadle (1981) using existing analyses of floristic site data, vegetation map unit descriptions, vegetation reports, expert knowledge and field checking to classify and assess the status of native vegetation. Extensive field surveys check previous classifications and help to fill gaps where data are lacking. The vegetation classification generally conforms to the "plant association" level as defined in Beadle & Costin (1952) or Levels 5/6 in the National Vegetation Information System (NVIS) (ESCAVI 2003) that are included in vegetation classification hierarchal level D in the interim NSW Vegetation Type Standard (Sivertsen 2010). While the NSWVCA classification is mainly based on floristic variation, abiotic factors such as substrate and soil are taken into account in defining plant communities (Benson 2006).

The NSWVCA is assisting environmental site assessment with its classified plant communities progressively being including in the Biometric Tool in the NSW Property Vegetation Planning process (Gibbons *et al.* 2005 at web site: http://www.nationalparks.nsw.gov.au/PDFs/Biometric_manual_1_8.pdf). It is also useful for setting priorities in national, state, regional and local planning scheme targets and for setting priorities for new conservation reserves or secure property agreements to fulfil a comprehensive, representative protected area system in NSW. The inputs, products, uses and outcomes of the NSWVCA project are summarised on the flow diagram in Figure 2 in Benson (2008, page 600).

The DVD in the back pocket of the journal contains the descriptions of the plant communities in the BBS, NAN and western NET Bioregions and updated information on the plant communities previously described for the NSW Western Plains (Benson 2006) and NSW South-western Slopes Bioregion (Benson 2008). The DVD also contains a read only version of Version 3 of the NSWVCA database.

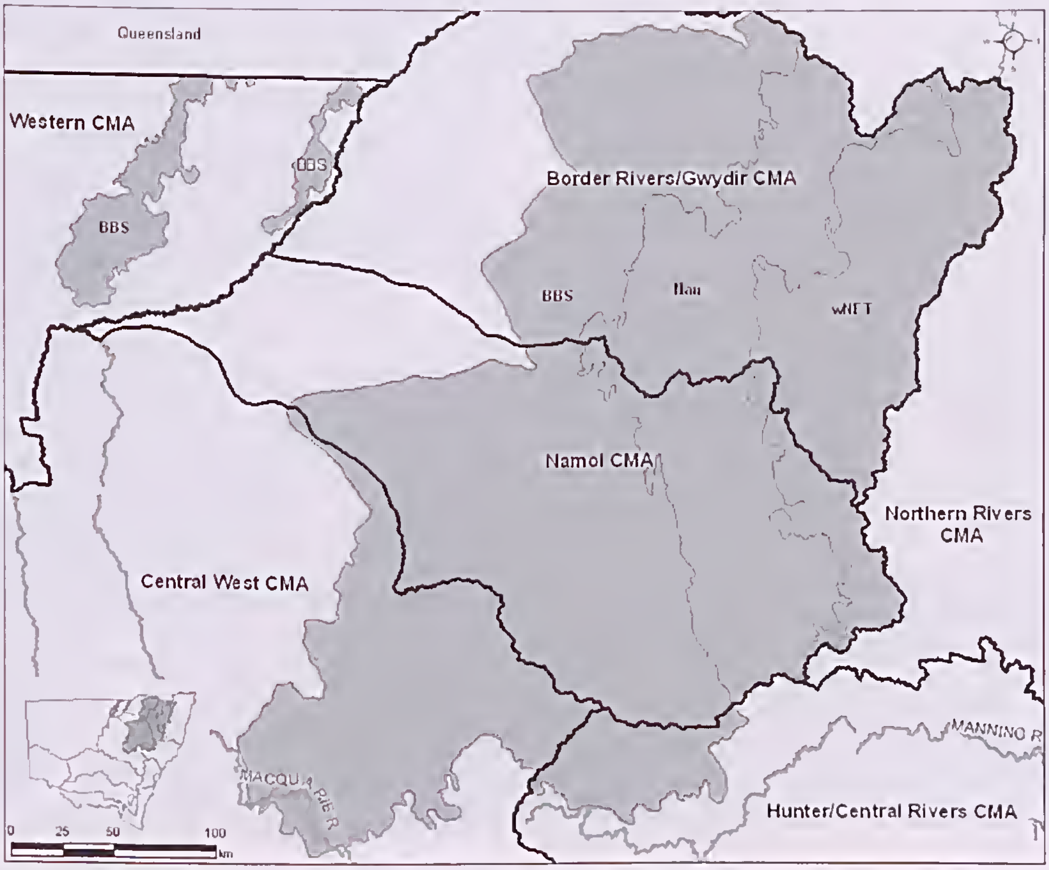

Fig. 2. The 9.3 million hectare Brigalow Belt South, Nandewar and west-New England Bioregions showing Catchment Management Authority areas (CMAs) that intersect the study area.

The study area: BBS, NAN and west-NET Bioregions

The study area includes the NSW sections of the Brigalow Belt South Bioregion (5,629,014 ha, 7 % of NSW), Nandewar Bioregion (2,070,476 ha, 2.6 % of NSW) and the New England Tableland Bioregion (NET) west of the Great Dividing Range (1,577,234 ha, 1.95% of NSW) based on the boundaries in version 6.1 of the IBRA bioregions in Thackway & Cresswell (1995). The total area of 9,278,283 ha is 11.6 % of the area of NSW (Figure 2). These two and one half bioregions contain all of part of 26 IBRA sub-regions defined in DEC NSW (2004a) (Figure 3). The nine sub-regions in the BBS Bioregion include the two western outlying sub-regions of Narandool and Moonie-Barwon-Collarenbri Interfluve along with the Northern Outwash, Pilliga Outwash, Pilliga, Talbragar Valley, Liverpool Range, Liverpool Plains and Northern Basalts sub-regions; the three sub-regions in the NAN Bioregion are Peel, Inverell Basalts and Nandewar, Northern Complex; the western half of the New England Bioregion contains all or parts of 14 sub-regions including the total area of the Eastern Nandewars, Bundarra Downs, Tingha Plateau, Moredun Volcanics, Beardy River Hills, Severn River Volcanics, Binghi Plateau and Deepwater Downs sub-regions and parts of the Stanthorpe Plateau, Tenterfield Plateau, Northeast Forest Lands, Glen Innes-Guyra Basalts, Yarrowyck-Kentucky Downs and Armidale Plateau sub-regions.

The study area comprises all of the North Western Slopes, the northern part of the Central Western Slopes and the western half of the Northern Tablelands Botanical Divisions defined in Anderson (1961). It includes the eastern two-thirds of the Border River-Gwydir and Namoi Catchment Management Authority areas (CMAs) (Figure 2). The vegetation in the western third of these two CMAs was classified in Version 1 of the NSWVCA (Benson *et al.* 2006). The north-eastern corner of the Central West CMA and the north-western edge of the Hunter-Central Rivers CMA are also in the area (Figure 2). A total of 20 Local Government Areas (LGAs) are fully or partly within the area being: all of Gunnedah, Gwydir, Inverell, Liverpool Plains, Warrumhungle LGAs; and parts of Armidale-Dumaresq, Coonamble, Dubbo, Gilgandra, Glen Innes, Guyra, Mid-western Regional, Moree Plains, Narrabri, Tamworth Regional, Tenterfield, Upper Hunter, Uralla, Walgett and Wellington LGAs.

The area's southern boundary is an east-west line from north of Scone in the upper Hunter Valley to south of Dubbo on the western slopes. The area extends approximately 400 km to its northern boundary at the Queensland border. Its eastern boundary is the Great Dividing Range in the north and the Sydney Basin and NSW North Coast Bioregions in the south. The western boundary is the Darling Riverine Plain Bioregion. From south to north, the study area includes the inland towns of Dubbo, Mendooran, Coolah, Merriwa, Manila, Tamworth, Quirindi, Gunnedah, Coonaharabran, Pilliga, Narrabri, Uralla, Moree, Warialda, Uralla, Glen Innes, Tingha, Inverell, Emmaville, Ashford, Tenterfield and Yetman.

Climate

The area includes four of the nine Australian climate zones defined by Stern *et al.* (2000) (see Figure 3 in Benson 2006) that cover NSW. These are Dry Subtropical – Moderately Dry Winter, Temperate – No Dry Season (hot summer), Temperate – No Dry Season (warm summer) and Montane – No Dry Season (mild summer). This climate variation is in part explained by large altitudinal range from 1500 m on the New England Tablelands, Liverpool Range and on Mount Kaputar to less than 100 m elevation on the outwash plains in the western BBS Bioregion. Most of the area has hot summers and cool to mild winters. Mean annual rainfall varies from 440 mm at Lightning Ridge in a north-west outlying sub-region of the BBS Bioregion to 850 mm at Tenterfield on the northern end the NSW Great Dividing Range and 830 mm at Murrurundi on the eastern Liverpool Range at the southern end of the Great Dividing Range. In between, Dubbo receives 550 mm, Narrabri 657 mm, Tamworth 670 mm and Yetman 660 mm of average annual rainfall (Bureau of Meteorology 2010). Maximum annual average monthly temperatures range from 28°C max., 12°C min. at Lightning Ridge to 17.9°C max., 9.3°C min at Guyra. Typical mean maximum daily temperatures of some other towns are 24°C at Dubbo, 26.5°C at Narrabri, 24.3°C at Tamworth and 26.9°C at Yetman with hot summer maximums such as 33.7 at Moree.

Physiography

The physical characters of the BBS, NAN and NET Bioregions are summarised in NSW NPWS (2003). The region contains complex geological structures with numerous substrates and soils (Great Soil Groups after Stace 1968 are referred to here). In the east, the NET Bioregion is dominated by the New England Fold Belt described in Harrington (1977) with major units mapped in Binns (1967). This region contains intensely folded stratified rocks with a number of strike faults. Fine-grained sedimentary rocks develop red and yellow clay or podsolic soils. Tertiary basalts cover the high part of the NET between Guyra and Glen Innes to south near Armidale and Uralla, forming krasnozem, chocolate and black earth soils. Plutonic intrusions of various types of granite, ademellite and leucogranite occur throughout including near Tenterfield, Mole Creek (Binghi Batholith) near Emmaville in the north and around Warrabah in the upper Namoi River in the south. These form various podsolic and lithosol soils. Acid volcanic outcrops (mainly rhyolite) occupy the western edge of the NET and are widespread in the adjoining Nandewar Bioregion in locations such as Severn River/Pindari Dam, Kings Plains and near Ashford, forming red earth and red clay soils. Quaternary alluvium occurs in valley bottoms forming brown and grey clays or humic gley and peaty soils in fens and swamps where drainage is impeded.

The southern parts of the NAN and BBS Bioregions contain the Gunnedah Basin continuous between the Sydney Basin to the south and the Bowen Basin in Queensland to the north, that combined extend over 1700 km of eastern Australia (Tadros 1993). The sediments of the Gunnedah Basin include Permian and Triassic sandstone (e.g. Trinkey hills) with fine-grained rocks outcropping throughout. These sediments are overlain by large areas of Tertiary basalt or dolerite with massive basalt layers comprising the Liverpool Range at elevations of over 1000m containing large areas of krasnozem soils derived from the basalt. The basalt extends to the rolling hills around the town of Merriwa in the upper Hunter Valley where black earth soils predominate. There the basalt overlays Permian fine-grained sediments outcropping on much of the valley floor in the Hunter Valley with Narrabeen sandstone and Permian conglomerates on hills around Scone, Goulburn River and in the Wollemi National Park in the north-western part of the Sydney Basin Bioregion. The level areas of the Liverpool Plains are composed of deep alluvium that is over 100m deep in places. This alluvium is mostly basaltic in origin, developing cracking black earth, black clay, brown clay and chocolate earth soils with areas of grey clay in lake beds, swamps or on aeolian lunettes such as at Goran Lake. These soils grade into red-brown earths and earthy sand soils on alluvium derived from conglomerates and sandstones or red to brown clays and chernozem or euchrozem soils on slightly undulating floodplains at the edge of the plain (Banks 1995, 1998). Some parts of the Liverpool Plains contain high levels of salinity.

Immediately east of the Liverpool Plains is the Melville Range composed of volcanic and metamorphic substrates being bounded by the Hunter- Mooki thrust fault. To the west of the Liverpool Plains fine-grained sedimentary rocks in the Purlewaugh Beds outcrop near Garawilla and to the south. North and west of the Liverpool Plains is the Surat Basin which is part of the Great Artesian Basin (Stroud 1990). It contains deep layers of Jurassic or Cretaceous sediments including quartzose Pilliga Sandstone that outcrop over large areas between Dubbo to Yetman in the BBS Bioregion, including throughout the Pilliga Scrub forests. The highly siliceous Pilliga Sandstone contains siliceous sands, yellow earthy sands, yellow earths, texture contrast podzolic soils and solodized solonetz soils (Murphy & Lawrie 1998). Colluvial sandy outwashes at the western edge of Pilliga sandstone outcrops, such as in the north-western Pilliga

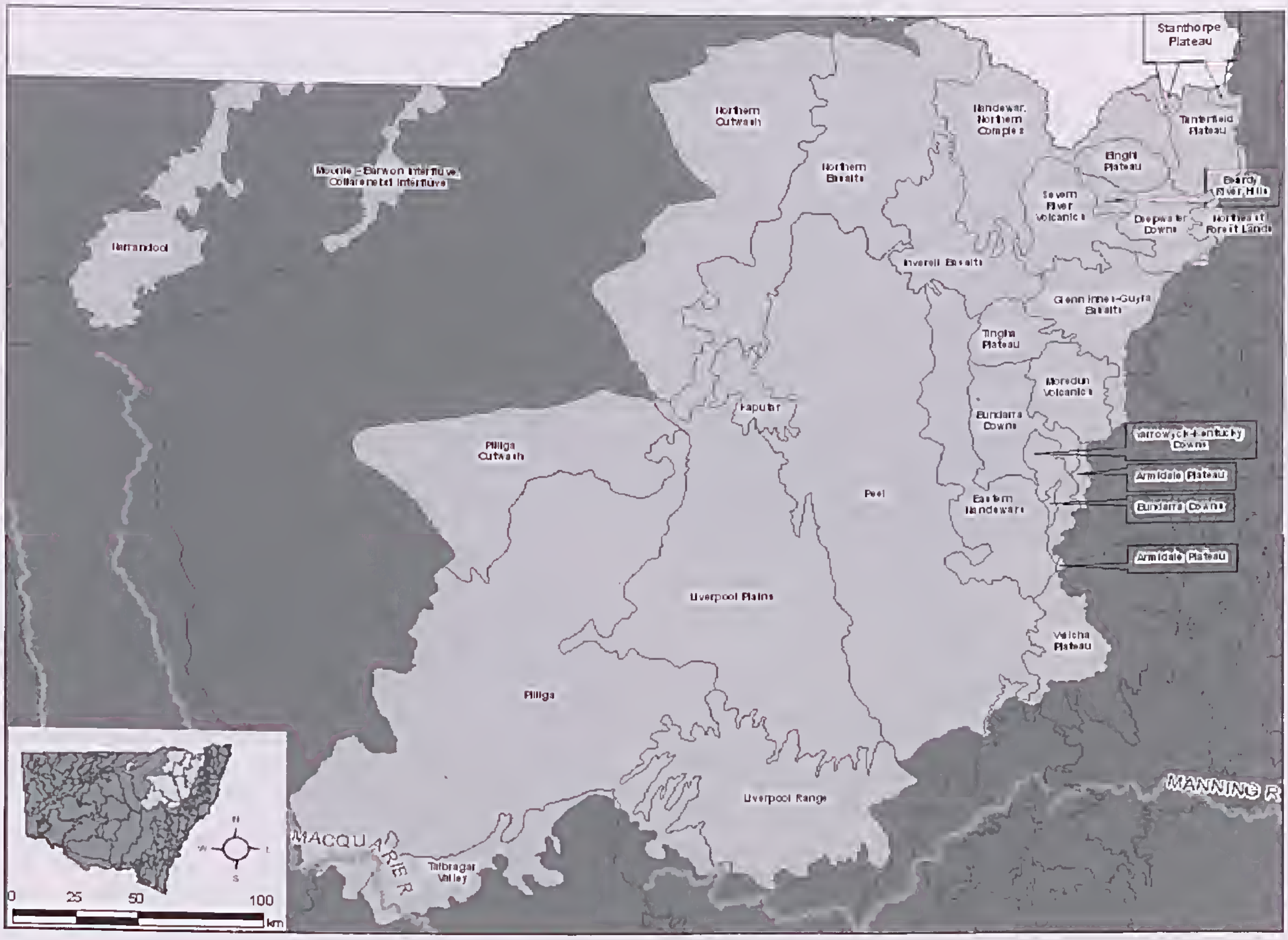

Fig. 3. The 26 IBRA Sub-regions within the Brigalow Belt South, Nandewar and west-New England Bioregions.

forests and north-west of the Bebo forests near Yetman extending to the "Yelarbon Desert" in Queensland (Fensham *et al.* 2007) contain highly alkaline, dispersible sodic soils that contain unusual types of vegetation.

Acid volcanic intrusives composed mainly of trachyte lithology are a prominent feature of the Garawilla, Warrumbungles and Mount Kaputar regions in the vicinity of Coonabarabran, Gunnedah and Narrabri townships. Numerous trachyte "plugs" outcrop spectacularly in these landscapes exhibiting cliffs and scree-slopes that house distinctive vegetation types. These are remnants of volcanoes that erupted between 13–21 million years ago with 1000m of overlying rock having been eroded exposing resistant trachyte plugs and dykes of ancient volcanic necks and vents (Duggan & Knudson 1993). The highest peak in the Warrumbungle National Park, Mount Exmouth is 1206 m while Mount Kaputar in Mount Kaputar National Park is 1510m. The higher elevations of Mount Kaputar contain western extensions of typically northern tableland vegetation.

Tertiary basalt covers a large area of rolling hills and valleys between Inverell and Yetman in the northern parts of the NAN and BBS Bioregions forming deep chocolate loamy soils that have mainly been cleared for cropping. To the north of Inverell, large areas of Permian acid volcanic rocks (mainly rhyolite) outcrop on the Severn River containing shallow, yellow sodolic and yellow podzolic soils in rugged landscapes of steep, rocky hills. Similar acid volcanic outcrops occur on hills around Ashford along with granite and leucogranite intrusions with the latter containing siliceous sand soils with limited areas of gleyed podzolic soils in swamps. These are interspersed with fine-grained sedimentary and metasedimentary outcrops such as mudstone and shale occurring in some valleys forming red and brown clay soils. Small areas of basalt capping occur east of Ashford and quaternary sands occur on plains and along river systems north-west of Ashford near the Queensland border.

A key geological feature that crosses the NAN Bioregion is the 350 km Great Serpentinite Belt (Leitch 1980) containing outcrops of serpentinite along an arc from Port Macquarie on the NSW North Coast to the NSW North Western Slopes. One of the largest outcrops of this serpentinite, containing a large asbestos deposit, occurs at Woodsreef near Barraba (Glen & Butt 1981).

The two disjunct western BBS sub-regions north of Walgett, including the opal mining town of Lightning Ridge, contain marine sedimentary substrates of Cretaceous Age (circa. 110 million years b.p) age (Smith & Smith 1999). The main rock types in these sub-regions are claystone and sandstone with breccia along with secondary formed silica-rich opal deposits. This hard rock country grades into alluvial plains and floodplains plains composed of grey and brown clays along the Barwon and Narran Rivers more typical of the adjoining Darling Riverine Plain (Benson *et al.* 2006). Lake sediment and aeolian lunettes occur at Narran Lake which straddles the border of the BBS and Darling Riverine Plains Bioregions.

Land use and land degradation

A number of Aboriginal tribes occupied the NSW Northern Tablelands and North-western Slopes for thousands of years before displacement by European pastoralists from the 1830s. The Anaiwan Tribe occupied most the New England Tableland (Connah *et al.* 1977). The Bigambul people occupied lands around Bonshaw – Yetman and lands extending into modern-day Queensland in the northern part of the study area. A large area of the north-western alluvial plains and slopes west of Inverell, including current day Moree and Narrabri were occupied by the Gamilaroi people. An event of notoriety was the Myall Creek massacre where 28 Willayarady people were killed by European settlers at Myall Creek near Bingara in 1838 (Milliss 1995). Little is recorded on how Aborigines managed the land although some discussion on burning practices is provided in Benson & Ashby (2000) for the New England region and contrary views on fire in relation to the structure of the Pilliga Scrub forests are discussed in Rolls (1981), Norris *et al.* (1991), Norris (1996) and Benson & Redpath (1997).

The earliest European explorer to visit the area was John Oxley in 1818 (Oxley 1820) who traversed the Warrumbungle Range, the Pilliga Scrub, the Liverpool Plains and eastwards to the New England Tableland before descending to the coast near modern day Port Macquarie. His journal notes on vegetation offer insights on the pre-European structure of various vegetation types across this traverse. The botanist Alan Cunningham accompanied Oxley in 1818 and subsequently undertook his own explorations. In the early 1820s Cunningham published memoirs of a route from Bathurst to the Liverpool Plains (Cunningham 1825). Later, in 1827, Cunningham established a route from Sydney to Moreton Bay via the inland. During this trip he traversed the Liverpool Plains through to modern day Bingara, Warialda, Yetman and into Queensland returning via Ashford to Warialda. The notes on pasture potential by these explorers led to rapid settlement by squatters and the the introduction of domestic livestock onto the Liverpool Plains and to other parts of the north-western slopes and northern tablelands.

A history of European settlement of the New England region is provided in Atchison (1977) and is summarised in Benson & Ashby (2000). A similar pattern of settlement applies to the whole study area. Squatters moved in during the 1830s with sheep and cattle, immediately causing loss of topsoil through erosion with some weed invasion. Tree clearing accelerated after 1870 in spurts of activity including after World War II. Logging of state forests commenced in the late 1800s and focused mainly in the wetter climes of the NET Bioregion (Atchison *et al.* 1977) and in the White Cypress Pine (*Callitris glaucophylla*) forests in the BBS Bioregion such as the Pilliga Scrub (Rolls 1981). Little old growth forest remains in these state forests but large areas of regrowth forest survive. The impacts of logging woodlands and forests for firewood in the NET Bioregion are documented in Wall (1997). An insidious threat to some higher elevation woodland areas on the NET has been insectivorous dieback events (Nadolny 1995). This gained national attention in the 1970s due to millions of tree deaths and subsequent clearance of the deadwood for firewood changing the landscape of large parts of the New England.

Clearing of the western parts of the BBS and NAN continued up to recent times as agriculture intensified from grazing to cropping on better soils. Approximately 90% of the rich soils on the Liverpool Plains now support crops such as cotton, sorghum and wheat and repeated cropping covers large areas from Quirindi in the south to Inverell and Moree extending onto the Western Plains (NSW DECCW 2010).

Opal mining occurs at Lightning Ridge and in surrounding areas. Tin mining and gem extraction was extensive in the Tingha – Emmaville region on the western side of the NET Bioregion. Gold was mined at various locations in the NET Bioregion including near Tenterfield. Coal exploration and mining is rapidly expanding in the Gunnedah Basin on the Liverpool Plains and a smaller basin near Ashford has been mined in the past

Today, approximately 60% of the woody cover of native vegetation (canopy cover >20%) in the BBS, NAN and west NET has been cleared (Figure 4) (DECCW woody non-woody land cover layer 2009). Approximately twice the amount of woody native vegetation is present in this region compared to the NSW South-western Slopes Bioregion described in Benson (2008). However, a significant difference between the north-western slopes and the south-western slopes is the composition of the ground cover in both cleared and treed landscapes. Except for the cropped areas, the ground cover in the North-western Slopes is dominated by native grasses and forbs forming large areas of natural grasslands or derived grasslands where trees have been removed. Adding these native ground cover areas to the remaining woody vegetation implies that at least 70% (author's estimate) of the region contains "native vegetation" as defined in the NSW Native Vegetation Act 2003. This Act defines native ground cover if >50% of a sample area is composed of indigenous species when species are most vigorous in their annual growth cycle. In contrast, most of the ground cover extent in the NSW South-western Slopes Bioregion is dominated by exotic pasture species (Benson 2008).

Approximately 16% of the study area occurs in lands of public tenure. Protected areas account for approximately 7% of this. These include all types of conservation reserves

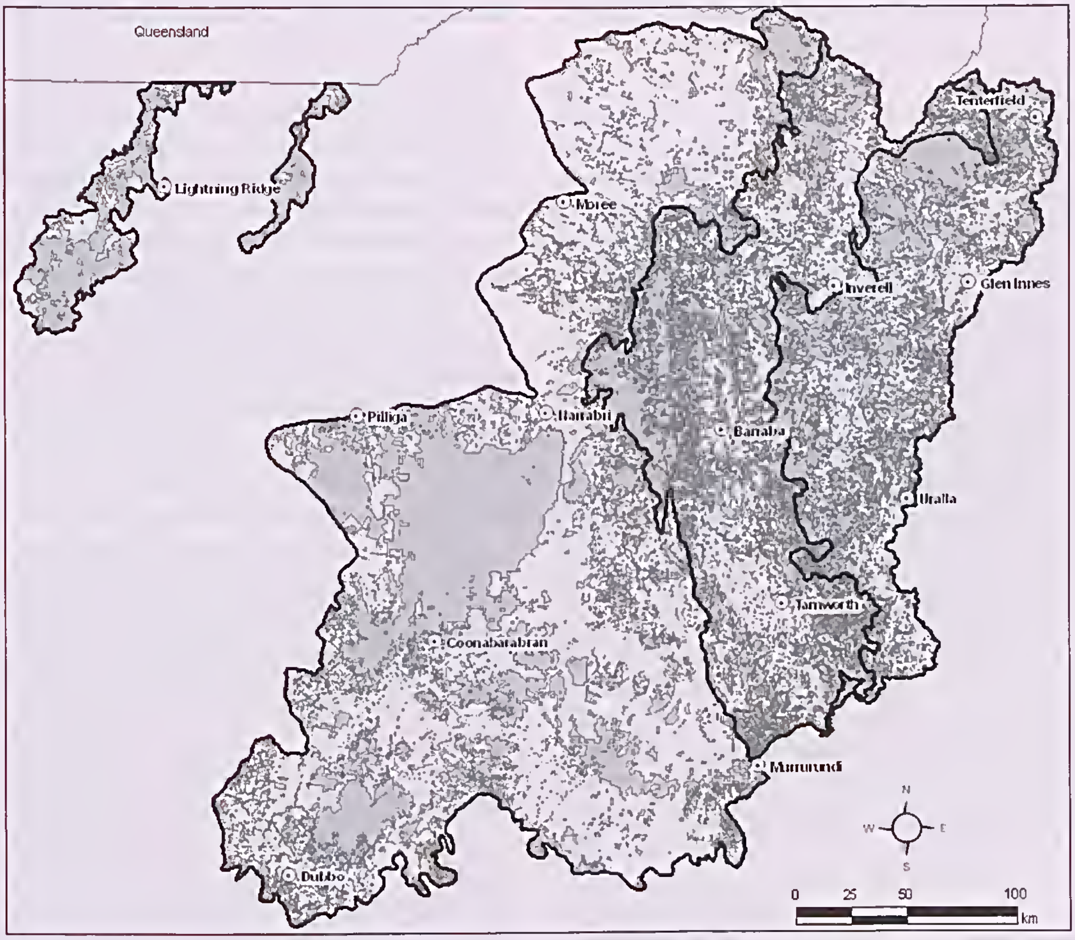

Fig. 4. Map showing cleared areas or native grassland (white) and woody (>20% crown cover) native vegetation remnants (grey) in the Brigalow Belt South, Nandewar and west-New England Tablelands Bioregions (DECCW woody non woody GIS layer 2009).

and most secure property agreements, as defined in Benson (2006) and based on IUCN (1994) (updated in Dudley 2008). State Forest tenure accounts for approximately 5% of the area and less than 5% is held in other public ownership, such as travelling stock reserves and road reserves (excluding Western Division Land Leases that cover BBS sub-regions west of the Barwon River).

The largest areas of woody native vegetation occur on low nutrient soils derived from sandstone, granite and acid volcanic substrates. They include the sandstone forests in the 500,000 hectare Pilliga Scrub between Coonabarabran and Narrabri, half of which is now protected in conservation reserves; woodlands between Narran Lake Nature Reserve and Lightning Ridge in the far western segment of the BBS Bioregion; 150,000 ha of sandstone forest in the Goonoo Goonoo forest region near Dubbo, 50,000 ha of forests on sandstone and acid volcanic substrates in the Yetman region, 70,000 ha of woodlands on trachyte and sediments in the Nandewar Range centred on Mount Kaputar; 40,000 ha on sandstone and trachyte in the Warrumbungle National Park region; 60,000 ha of tall forests and woodlands on the steep slopes and peaks of the basaltic Liverpool Range;100,000 ha on granite outcrops in the Binghi region north of Emmaville; and over 40,000 ha on acid volcanic hills around the Severn River (Figure 4). Numerous smaller patches of woodlands, forests and grasslands occur throughout the area.

Previous botanical studies

After the early explorations and specimen collections by Alan Cunningham from 1818–1828, botanical studies in the region were rare for the next 50 years. A general description of the New England vegetation was produced in Christie (1876) in relation to geology. General accounts of the vegetation of the New England and upper north-western slopes are given in Turner (1903, 1906) and Cambage (1904, 1908, 1912) who produced species lists for localities such as Deepwater, Torrington, Emmaville, Barraba and Nandewar Mountains (Mount Kaputar area). The first survey of the natural pastures of the New England was published by Roe (1947) while an ecological survey of the New England region was undertaken by CSIRO from 1951 to 1954 and formed the basis of a relatively comprehensive list of vascular plants (Gray 1961). Williams (1963) gave an account of the vegetation in a broad east-west transect of the tablelands and slopes and the Soil Conservation Service of NSW (1970) described vegetation in relation to soils on the Liverpool Plains and elsewhere. The NSW Forestry Commission (1989) used aerial photographic interpretation (API) to "type" most of the state forests using a forest type code system based on tree dominance canopy cover. Lindsay (1967) mapped forest types in most of the Pilliga state forests including conducting extensive field checks by traverses on horseback. His maps were later compiled to form a Pilliga forest type map (NSW NPWS (2000a). Similar forest typing was produced over state forests near Dubbo that were later subjected to separate API mapping (NSW NPWS 2000a). Beadle (1971–1987) published a flora of north-eastern NSW which provided the first systematic account of the vascular flora for the entire study area. Beeston *et al.* (1980) classified the Poplar Box (*Eucalyptus populnea*) communities in Queensland and NSW. Pulsford (1984) described the status and distribution of Brigalow (*Acacia harpophylla*) in NSW. Beadle (1981) described the vegetation alliances and major associations of the region in his seminal book *The Vegetation of Australia.*

Since 1990, specific botanical surveys have been undertaken mainly by government agencies for a variety of purposes. Binns (1992, 1995) and Chapman & Binns (1995) undertook floristic surveys and described vegetation communities of the State Forests of the Glen Innes, Tenterfield and Walcha-Nundle-Styx forest management areas. Surveys of state forests in the BBS Bioregion included Binns (1997) survey of the Coolah Tops on the western Liverpool Range (now mostly a national park) and Binns *et al.* (1999) and Binns & Beckers (2001) descriptions of floristic patterns in the forests comprising the Pilliga Scrub (approximately half of which is now in conservation reserves). Hager & Benson (1994) produced a non-spatial vegetation classification and conservation assessment of the forests of north-eastern NSW intersecting with the higher elevation part of the west NET Bioregion. Le Broque & Benson (1995) floristically surveyed and classified the vegetation of the Ashford 1:100 000 map sheet while Sparshott (1995) surveyed and mapped the adjoining Texas 1:100 000 map sheet to the north, mainly in Queensland. Clarke *et al.* (1995) described the flora and vegetation communities along the "Eastlink" powerline corridor between Armidale, NSW and Gatton in Queensland. Hunter & Clarke (1998) analysed and described floristic communities associated with granite outcrops of the New England Batholith. A plant species list of north-western slopes part of the mid-upper Namoi River catchment was produced in Hosking & James (1998). The vegetation in the extreme southern part of the BBS Bioregion, around the town of Merriwa in the upper Hunter Valley, was broadly mapped by McRae & Cooper (1995).

Benson & Ashby (2000) intensively surveyed, classified and mapped 24 vegetation types at 1:25 000 scale over the Guyra 1:100 000 map sheet on the New England plateau. Whitehead (2000) mapped the vegetation in the Coonabarabran Shire applying Forest Type nomenclature (Forestry Commission of NSW 1989) to the vegetation types. Cannon *et al.* (2002) classified the vegetation and mapped more broadly than their floristic classification the vegetation in the Bellata, Gravesend, Horton and Boggabri 1:100 000 map sheets. Ismay *et al.* (2004) produced a fine-level floristic classification mapped at broader thematic levels for the Coonabarabran, Tambar Springs, Cobbora, Coolah and Mendooran 100 000 map sheets. Regional vegetation mapping also exists for the Yallaroi, Ashford, Bingara and Inverell 1:100 000 map sheets (YABI) (DECC 2008) centred upon the northern NAN Bioregion extending into the BBS Bioregion to the west and the west-NET to the east. A further three 1:100 000 map sheets (Cobbadah, Manilla and Tamworth in southern NAN) were partly completed at the time of writing (DECCW GIS files). API maps cover some other parts of the study area such as the Blackville and Murrurundi 1:100 000 map sheets (Anon. 2002) in the southern part of the BBS Bioregion and the Moree Plains Shire (Peasley 2001) on the western edge of the BBS Bioregion. Williams & Metcalfe (1991) assessed the natural values of Travelling Stock Reserves (TSRs) in the Armidale district in the NET Bioregion. Austen (2002) assessed the natural values of TSRs in the Narrabri, Northern Slopes, Moree and Tamworth Rural Lands Protection Board (RLPB) districts. Spark (2006) produced a similar assessment in the Tamworth Rural Lands protection Board TSRs.

Large regional vegetation surveys, mapping, modelling, or descriptive studies include: the mostly abiotic classification of land units covering western NSW and on the New England Tableland (Morgan & Terrey 1992, 1999); forest ecosystem modelling (NSW NPWS 1999) in the upper and lower North-east NSW Comprehensive Regional Assessments (CRA) that extends into the New England and eastern Nandewar part of the study area; vegetation mapping and modelling in the Nandewar Bioregion for the Western Regional Assessment of forests (NWRA) (DEC NSW 2004) involving the analysis of nearly 2000 floristic plots; vegetation modelling and mapping of the BBS Bioregion for the Western Regional Assessment of forests (Resource and Conservation Assessment Council of NSW (RACAC) 2004) based on approximately 3500 floristic plots. The vegetation in the upper Hunter Valley in the southern-most part of the BBS Bioregion and areas bordering the NAN / NET Bioregions has been classified as part of the Hunter-Central Rivers vegetation classification based on the analysis of over 4000 floristic plots with complementary expert additions to the classification (Sommerville 2009). These bioregional-wide analyses were complemented by extra sampling and analysis of approximately 1400 floristic plots on the west-NET Bioregion as part of this project (Eco Logical Australia 2008).

Pre-European, broadly-classified vegetation maps have been produced for the Moree Plains Shire (White 2002) and the Namoi CMA (Eco Logical Australia 2010).

The limited areas of rainforest in the area have been surveyed by Curran (2006) who researched their floristic variations from the NSW north-western slopes from the upper Hunter Valley to Yetman. This added to and collated the classification of NSW rainforest types in Floyd (1990), the survey and classification of Ooline (*Cadellia pentastylis*) forests in Benson (1993) and semi-evergreen vine thicket descriptions in Holmes (1979) and Benson *et al.* (1996). Curran *et al.* (2008) subsequently produced a classification of the north western slopes dry rainforests and Curran & Curran (2005) document a southern limit of Ooline near Gunnedah. The wetter rainforest types of the southern, protected slopes of the Liverpool Range are described in Fisher (1980, 1985) and Floyd (1990).

Native grasslands and grassy woodlands have been the subject of considerable research, much of it in relation to the grazing of livestock in those ecosystems. Lodge & Whalley (1989) provides a description, review and bibliography of "native and natural pastures" of the study area. Duggin & Alison (1984) mapped the Liverpool Plains grassland remnants. McGann & Earl (1999) sampled, classified and describe several grassland types in the Moree Plains region on the western edge of the BBS Bioregion. A thorough survey of the grassland in Kirramingly Nature Reserve, south of Moree was produced in Clarke *et al.* (1998). More broadly, Hosking (2001) provided a plant species list for the Liverpool Plains while Lang (2008) defines an original extent for naturally-treeless grasslands on the Liverpool Plains. More recently, the floristic composition of the grasslands of the Liverpool Plains has been investigated in Allen & Benson (in prep.) involving repeated sampling of the grasslands in spring, summer, dry and wet periods. General guidelines on grassland types and their management have been provided to catchment management authorities through articles such as Nadolny *et al.* (2009).

Some of the lagoon wetlands of the New England were broadly mapped in Benson & Ashby (2000) with a more detailed classification of the bogs provided in Hunter & Bell (2007) and *Carex* fens of the New England and the north-western slopes classified in Hunter & Bell (2009). Beckers (1995) produced a floristic survey of the riparian zone of the Namoi River. Other wetland types have been documented in various reports on reserves or in the NSWVCA database based on rapid NSWVCA sampling in Benson (1999–2009).

Since the 1990s, most public land conservation reserves: Nature Reserves (NR), National Parks (NP), State Conservation Areas (SCA), Aboriginal Areas (AA) and the Community Conservation Area Zone (CCAZ) reserves) along with a limited number of private land secure property agreements (including Voluntary Conservation Agreements VCAs) have been floristically surveyed with maps of vegetation communities produced at either 1:25 000 or 1:50 000 scale. In most instances these surveys have produced local-scale, robust vegetation classifications and detailed vegetation maps that have substantially contributed to the NSWVCA classification and provided a basis for the audit of vegetation types in protected areas. Conservation reserve survey and mapping by author with bioregion noted include (surveys by J.T. Hunter are listed after): Bell (2009) Murrurundi Pass and Crawney Pass National Parks BBS/NAN), Benson (1979) Wongarbon Nature Reserve (BBS), Benson & Andrew (1990) Ben Halls Gap National Park (NET), Clarke *et al.* (1998) Kirramingly Nature Reserve (BBS), Clarke *et al.* (1998a) Torrington State Conservation Area (NAN), Clarke *et al.* (2000) Single National Park (NET), Hill (1999) Goulburn River NP (Sydney Basin), Hill & Peake (2000) Towarri NP (BBS), Holme (1990) vegetation map of Warrumbungle NP (BBS), Lembit & Skelton (1998) and Morris & Edmondson (1988) Dapper NR (BBS), Porteners (1997) sub-alpine areas of Mount Kaputar (NAN), Porteners

(1998a) Weetalibah NR (BBS), Porteners (1998b) Binnaway NR (BBS), Porteners (2003) revegetation assessment of Warrumbungle NP (BBS), Porteners (2007) West Pilliga NP and SCA (BBS) and Zoete (2000) Barrington Tops NP (NET and NSW North Coast).

An extensive program of floristic survey, classification and vegetation mapping of numerous conservation reserves has been undertaken by Dr John T. Hunter on behalf of the NSW DECCW National Parks and Wildlife Service. These include: Hunter (1998) for Kwiambal NP (NAN), Hunter (1998a) for western Washpool NP (NET), Hunter (1999) updated in Hunter (2006c) for Narran Lake NR (BBS and Darling Riverine Plain Bioregions), Hunter (1999a) for Bald Rock NP (NET), Hunter (2000) Severn River NR updated in Hunter (2005b) for Severn River NR (NET/NAN), Hunter (2000a) for Kings Plains NP (NET/NAN), Hunter (2002) for a number of Tenterfield Nature Reserves (NET), Hunter (2003) for Arakoola NR (BBS/NAN), Hunter (2005) for Aberbaldie NR (NET), Hunter (2006) Midkin NR (BBS), Hunter (2006a) Carcunga NR (BBS/DRP), Hunter (2006b) Brigalow Park NR (BBS), Hunter (2006d) Dthinia Dthinnawan NR and NP (BBS), Hunter (2006e) Planchonella NR (BBS), Hunter (2006f) Gamilaroi NR (BBS), Hunter (2007) Yina and Imbota NRs (NET), Hunter (2008) Warrumbungle NP (BBS), Hunter (2008a) Deriah Aboriginal Area (AA) (BBS/NAN), Hunter (2008b) Somerton NP (NAN), Hunter (2008c,d,e,f) Playgan, Rusden, Montawa, Formosa additions to Mt Kaputar NP respectively (NAN), Hunter (2008g) Leard SCA (BBS), Hunter (2009) Bullala NP (BBS), Hunter (2009a) Gunyerwaldi NP (BBS), Hunter (2009b, i) Derra Derra and Molroy sections of Bingara NP (NAN), Hunter (2009c, e, f, g, h) five sections of Terry Hie Hie AA (BBS/NAN), Hunter (2009d) Irrigappa AA (BBS/NAN), Hunter (2009j) Hortons Falls NP (NAN), Hunter & Alexander (1997) section of Mt Kaputar NP (NAN), Hunter & Hunter (2003) Ironbark NR & Bornhardtia VCA (NET), Hunter & Sheringham (2005) Ngulin NR (NET), Hunter & Sheringham (2006) Melville Range NR (NAN), Hunter & Hunter (2008) Trinkey SCA (BBS), Hunter & Jobson (2008) Tinkrameanah NP (BBS), Hunter & Jobson (2008a) Biddon SCA (BBS), Hunter, Jobson & Bell (2008) Moema NP (BBS), Hunter, Jobson & Bell (2008a) Couradda NP (BBS/NAN), Hunter *et al.* (2008b) Bullawa Creek SCA (BBS), Hunter *et al.* (2008c) Bobbiwaa SCA (BBS/NAN), Hunter *et al.* (2008d) Killarney SCA (BBS), Hunter *et al.* (2008e) Wondoba SCA (BBS) and Hunter *et al.* (2008f) Garawilla NP (BBS)

Other botanical information includes species lists for particular areas including Williams (1983) species list for Planchonella Hill, Nadolny *et al.* (1996) list of species associated with the threatened plant *Astrotricha roddii*, species lists by Copeland (2001) for Stony Batter NR, Copeland (2001a) for The Basin NR and Copeland (2001b) for Watsons Creek NR, species lists by Harden (2004) for Gilgandra Native Flora Reserve and a list of plant species flowering times for Oxley Park near Tamworth in (Hosking 1990).

A number of determinations of endangered ecological community (EEC) listings by the NSW Scientific Committee (1999, 2000, 2001, 2001a, 2002 & 2003) describe vegetation types in the area, albeit most often in more broadly classified units than the plant communities in the NSWVCA.

The vegetation classification

As outlined in this paper's Introduction, the vegetation classification is based on collation and cross-checking of vegetation surveys, vegetation mapping, floristic site data and plot data analyses and extensive field checking. Most of the vegetation literature is cited in the above section "previous botanical studies". All sources used to define each plant community are listed in the "Authority" field in the NSWVCA database. All references are included in the NSWVCA Bibliography provided in a spreadsheet on the DVD in the back pocket of the journal.

Much of the vegetation classification is based on four large studies (RACAC 2004) for the BBS Bioregion, DEC (2004) for the NAN Bioregion, an analysis of 1400 full floristic plots in the west-NET Bioregion (Eco Logical Australia 2008) and the north-eastern forest ecosystem classification (NSW NPWS 1999) for the NET Bioregion. These were complemented by key regional surveys such as Benson & Ashby (2000) on the New England Tableland and Cannon *et al.* (2002) and Ismay *et al.* (2004) covering parts of the BBS and NAN Bioregions. Additional plant communities were described from numerous local-scale reports and publications listed above in the section on previous botanical studies that are also listed in the references. Expert botanists and ecologists assessed and reviewed the interim classification.

The analysis of the west-NET plot data is presented in Eco Logical Australia (2008). It applied similar methods and rules of combining data sets and analysis as DEC (2004) including standardising cover scores and eliminating duplicates. The analysis of data used the PATN statistical software package, using the DEND, FUSE and ALOC analytical methods in the PATN package (Belbin 1995) and the Bray–Curtis measure of association in an agglomerative cluster analysis (UPGMA) with a beta value of -0.1. This delivered 42 floristic groups for the west NET region that were subjected to fidelity analysis (Bedward 1999) to delineate diagnostic (high fidelity) species in each group which in turn assisted with producing an "equivalence" table to existing vegetation types described in the literature (Eco Logical Australia 2008).

Compared to the previous regions of NSW covered in the NSWVCA project (Benson *et al.* 2006) for the Western Plains and Benson 2008 for the NSW South-western Slopes Bioregion), the BBS, NAN and west-NET Bioregions contain substantially denser plot data and a greater number of regional and local analyses of those data. This resulted in over 90% of the plant communities being based on floristic groups derived from regional and local plot data analyses. Some wetland, riparian and woodlands on private land lacked plot data and were classified subjectively. Most of these poorly sampled communities were identified and sampled during field work where a full species list or dominant species were recorded (Benson 1999–2009). Confidence ratings in the "Classification Confidence Level" field in the database reflect the quality of data supporting each plant community definition and/or expert judgement on the distinctiveness of the community. Some poorly sampled vegetation types such as wetlands are in the authors' opinion more floristically distinct than some that are well sampled but closely allied to similar floristic groups. Plot sampling alone does not necessarily equate to high confidence in delineation of plant communities. The degree of sampling stratification, sampling density, consideration of seasonal variation between datasets and other factors are critical to numerical vegetation classification (Benson 2009).

Field reconnaissance was undertaken between 2005 and 2009 (Figure 5). The vegetation in the BBS Bioregion was checked at 571 sites over seven field trips, each averaging 12 days. The Goonoo – Dapper region was checked in May 2005, the Warrumbungle National Park and environs in September 2006, the Yetman to Warialda region in November 2007, Lightning Ridge and Narran Lake region along with the west Pilliga forests in April 2008, the Warialda to Narrabri region and north-eastern Pilliga forests in August 2008, the Coonabarabran – Liverpool Plains – Coolah Tops region and southern Pilliga forests in March 2009 and the Gunnedah to eastern Liverpool Range and Dubbo region forests in May 2009. The Nandewar and west New England Bioregions were checked at 234 sites through eight weeks of field survey between September 2007 and May 2008. In total, rapid sampling and photography of vegetation was undertaken at 805 sites over 20 weeks of field work involving 25,000 km of road traverse (Figure 5). At each field stop, dominant plant species and physiographic data were recorded along with a GPS recording. At some sites full floristic composition was recorded. This rapid sampling included types of vegetation previously poorly plot sampled. Copies of the field notebooks are held by the Botanic Gardens Trust, Sydney.

The vegetation in most of the conservation reserves in the bioregion was field-checked. This included checking fine-thematic level floristic classification and large-scale vegetation mapping produced to help manage the reserves. This detailed data greatly assisted the NSWVCA classification.

Correlations with Queensland Regional Ecosystems (Sattler & Williams 1999 updated in Queensland EPA 2007) are itemised in the NSWVCA database field "Interstate Equivalents" for relevant plant communities.

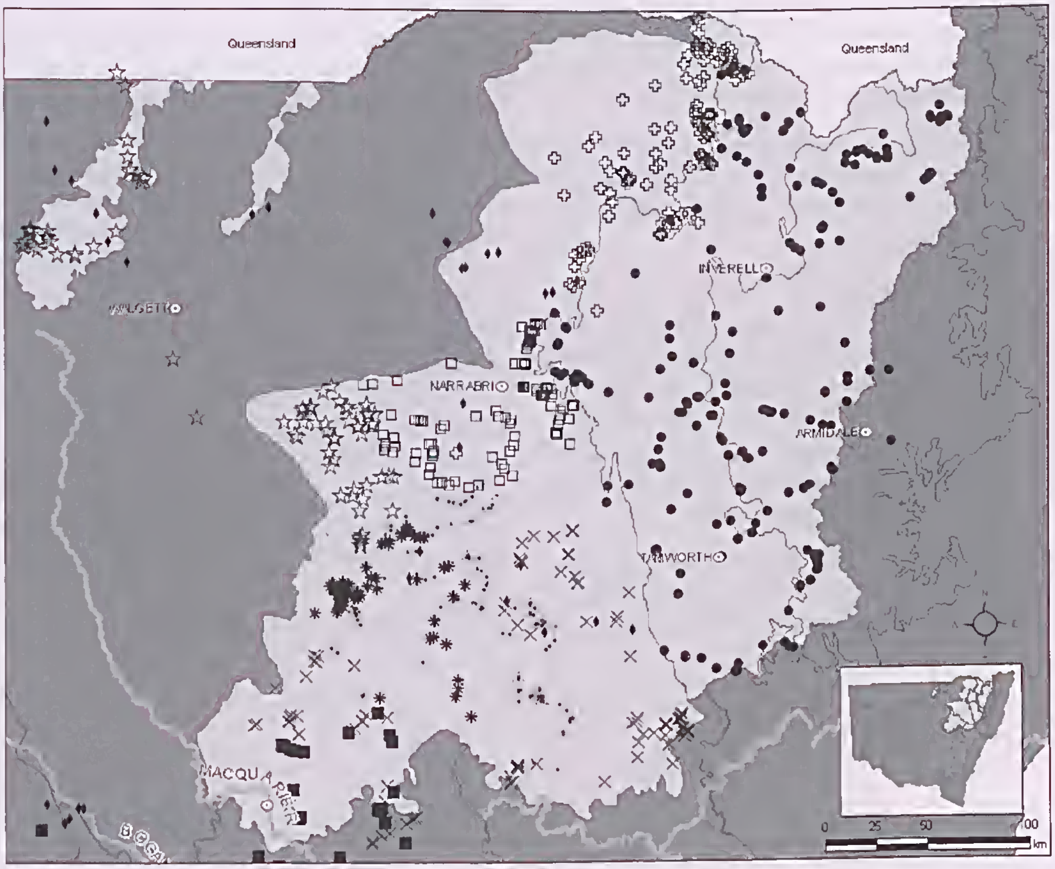

Fig. 5. Locations of 805 field checks undertaken during eight field trips between 2005 and 2009 that assisted in classifying the vegetation of the region.

Estimates of extent

The methods for estimating pre-European extent, current extent and extent in protected areas are outlined in Benson (2006), Benson *et al.* (2006) and reiterated in Benson (2008). Plant communities that extend east of the Great Dividing Range in the NET Bioregion or westwards into the NSW Western Plains are described across their full known distributional range.

All available vegetation maps were interrogated using geographical information (GIS) software (ESRI 1992–2009). Modelled extent estimates for many of the BBS Bioregion plant communities are provided in RACAC (2004), DEC (2004) and NSW NPWS (1999). These models provide initial estimates of overall extent for some communities but are unreliable in depicting vegetation type at particular locations in the field.

A composite map product was developed for the NAN and NET Bioregions (Eco Logical Australia 2008) using spatial layers covering these areas including NPWS reserves mapping (many projects), the Guyra mapping of Benson & Ashby (2000), the Nandewar model (DEC 2004) and Forest Ecosystem model (NSW NPWS 1999). The extant layer contained 460,000 polygons and pre-clearing layer 1,200,000 polygons including areas in the eastern NET Bioregion. Vegetation descriptions in the composite layer were assigned to a NSWVCA code yielding estimates of pre-European extent, current extent and extent in some reserves. Where polygons contained more than one VCA community the polygon area was apportioned to each community.

NSWVCA plant communities not described in major surveys required other means of estimating their extents. Extent estimates for these communities were derived from local-scale maps or from field traverses.

More accurate extent estimates are provided for plant communities in protected areas because most conservation reserves or secure property agreements have been surveyed and mapped at finer scales and were ground-checked in this project. Vegetation type data from protected areas includes GIS vegetation maps, plot data and general descriptions. Sources for the protected area extent estimates are provided in the "protected area comments" database field.

Approximately one third of the plant communities are distributed beyond the two and half bioregions covered here. Both pre-European and current extent estimates provided in the database record overall extent over all bioregions. Therefore, the sum of the extent statistics for all of the plant communities that occur in the BBS, NAN and west-NET Bioregions is larger than if the extent calculations were restricted to the those bioregions. Over 5 million hectares of the pre-European extent of some western-most BBS Bioregion plant communities occur outside the study area in the NSW Western Plains region (covered in Benson *et al.* 2006) or in NSW South-western Slopes Bioregion (covered in Benson 2008). For example, miniscule areas of the extensive inland plains Black Box woodland (ID37) and Coolabah Box open woodland (ID40) occur in the BBS Bioregion. A number of plant communities also mainly occur east of the Great Dividing Range in the eastern part of the New England Bioregion and some mainly occur to the south-east in the Sydney Basin Bioregion. In addition to the above, the summed current extent of plant communities includes estimated areas of derived types of native vegetation, particularly large areas of derived grasslands where trees have been removed but native grassland remains. If these derived native vegetation figures were excluded, the summed current extent of native vegetation in the NSWVCA database would be substantially lower.

Assessment of threat and protected area status

Each plant community was assigned a protected area adequacy code based on the proportion protected compared to original extent using the grading scale thresholds defined in the extensively applied conservation assessment criteria in JANIS (1997). These thresholds are outlined in field 79 in Appendix A in Benson (2006). Similarly, each community is assigned a threat code based on the threat criteria outlined in Appendix B in Benson (2006). Threatening processes are recorded and described in database fields. Threat criteria that include rules or thresholds are presented in Appendix B of Benson (2006). These are applied to assign one of five threat categories mirroring International Union for Conservation of Nature (IUCN) categories for species (IUCN 2001), i.e. Critically Endangered, Endangered, Vulnerable, Near Threatened and Least Concern. The NSWVCA threat criteria are one of several protocols influencing the development of IUCN international ecosystem risk assessment criteria (Rodriquez *et al.* 2010). The combined protected area/threat code succinctly summarises the status of each community.

Plant community nomenclature

The nomenclature used in the NSWVCA is discussed and described in Benson (2008, page 607). Three types of names apply to each plant community:

1. A NSWVCA database ID number. This would change only if a community was deleted, split or amalgamated;
2. A "Scientific Name" containing up to 12 binomial Latin names of characteristic species in up to three vegetation layers;
3. A "Common Name" (in English) that conveys a colloquial description of the vegetation. This Name usually includes one or more dominant / diagnostic plant species, the most prevalent vegetation structural formation (based on Walker & Hopkins 1990), a reference to soil, substrate or climate and a reference to the main geographical occurrence in which a plant community occurs, such as a bioregion or a locality. Some plant communities may be described without a reference to species. Although the "Common Name" may be more than 10 words long, it has the advantage of specifically describing a vegetation type for any region of Australia, thus avoiding confusion in provincial, national and international vegetation classifications.

Table 1. List of 315 plant communities in the Brigalow Belt South (BBS), Nandewar (NAN) and west-New England Tableland (w-NET) (west of Great Dividing Range) Bioregions by alphabetical order of formation group acronym showing their ID number; protected area/threat code; common name; pre-European extent, current and protected areas and ranges based on accuracy estimates; proportions in Catchment Management Authority areas (CMAs); and extent in protected areas with accuracy code.

Notes: The formation group acronyms are correlated to formation group names in Table 4 in Benson (2006) or as modified since in the NSWVCA database. The protected Area/Threat code and the protected area extent accuracy codes M, E1-E4 are explained in Benson (2006). The CD in the back pocket of the journal accompanying this paper contains a full report (90 fields) and a short report (28 fields) listing all plant communities in the BBS, NAN and w-NET Bioregions. * indicates communities that occur in protected areas in the Sydney Basin Bioregion. # = communities that occur in protected areas in the Darling Riverine Plains Bioregion. ** = communities that occur in protected areas in the NSW South-western Slopes Bioregion. + = communities that occur in protected areas in other Bioregions. Only the northern half of Towarri National Park in the BBS Bioregion is assessed.

Formation Group Acronym	Veg ID: Threat/Protected Area Code: Plant Community Common Name	ESTIMATED EXTENT: pre-European (range) Current Range (% pre-European) Protected Range (% pre-European)	% of Community in Bioregion	% of Community in CMA	Protected area name & size (ha) (* = also on Sydney Basin; # = Darling Riverine Plains; ** = NSW SW Slopes; += other)		Veg Area (ha) % Pre-European & Accuracy Code		
ASI	027: E/5a: Weeping Myall open woodland of the Darling Riverine Plains and BBS Bioregions	500,000 (350,000 - 650,000) ha 49,000 - 91,000 ha (9.8 - 18 %) 320 - 580 ha (0.049 - 0.17 %)	30-70% BBS 30-70% DRP <30% NAN	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Careunga NR	493	47	0.01	M
					Culgoa NP# +	36,520	100	0.02	E3
					Kirramingly NR	1,331	5	<0.01	E1
					Macquarie Marshes NR#	21,920	37	0.01	M
					Budelah NR#	4,055	20	<0.01	E3
					Midkin NR#	374	2	<0.01	M
					Narran Lake NR#	28,397	10	<0.01	E3
					Moema NP	2,024	7	<0.01	M
					Couradda NP	362	3	<0.01	M
					Bobbiwaa SCA	2,676	20	<0.01	M
					Terry Hie Hie AA	15,324	3	<0.01	E3
					Gwydir Wetlands SCA# +	4,292	198	0.04	M
ASI	035: CE/5a: Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, BBS Bioregion	120,000 (84,000 - 150,000) ha 8,400 - 15,000 ha (7 - 13 %) 460 - 560 ha (0.31 - 0.67 %)	30-70% BBS <30% DRP	30-70% Border R/Gwydir <30% Central West 30-70% Namoi <30% Western	Careunga NR	493	4	<0.01	M
					Brigalow Park NR	252	438	0.37	M
					Pilliga SCA	33,289	30	0.03	E1
					Leard SCA	1,175	5	<0.01	E3
					VCA0041	33	33	0.03	E1
ASI	077: E/4a: Yarran shrubland of the NSW central to northern slopes and plains	30,000 (15,000 - 45,000) ha 3,500 - 10,000 ha (12 - 33 %) 420 - 770 ha (0.93 - 5.1 %)	<30% BBS 30-70% CP <30% DRP <30% NSS	<30% Central West 30-70% Lachlan <30% Murray <30% Murrumbidgee <30% Western <30% Namoi	Cocoparra NP+	8,370	1	<0.01	M
					Cocoparra NR+	4,778	42	0.14	M
					Yathong NR+	108,869	500	1.67	E2
					Pilliga West SCA#	36,241	20	0.07	E3
					Pilliga West NP	8,005	30	0.10	E3
					Trinkey SCA	10,208	1	<0.01	E3
					Dowe NP	380	1	<0.01	E2
ASI	118: NT/4a: Gidgee chenopod woodland on red-brown clays in the semi-arid (hot) climate zone mainly in the Mulga Lands Bioregion.	500,000 (350,000 - 650,000) ha 210,000 - 390,000 ha (42 - 78 %) 7,400 - 13,000 ha (1.1 - 3.7 %)	<30% DRP 30-70% MUL <30% BBS	>70% Western	Culgoa NP# +	36,520	2,500	0.50	E2
					Narran Lake NR#	28,397	20	<0.01	E2
					Nocoleche NR+	71,162	2,600	0.52	E3
					Paroo-Darling NP# +	176,413	25	0.01	E1
					Ledknapper NR+	48,087	300	0.06	E3
					Toorale NP# +	91,527	5,000	1.00	E4

Formation Group Acronym	Veg ID: Threat/Protected Area Code: Plant Community Common Name	ESTIMATED EXTENT: pre-European (range) Current Range (% pre-European) Protected Range (% pre-European)	% of Community in Bioregion	% of Community in CMA	Protected area name & size (ha) (* = also on Sydney Basin; # = Darling Riverine Plains; ** = NSW SW Slopes; += other)		Veg Area (ha) % Pre-European & Accuracy Code		
ASI	120: NT/4a: Mulga shrubland on stony rises in the arid and semi-arid climate zones, mainly in the Mulga Lands Bioregion	1,000,000 (500,000 - 1,500,000) ha 300,000 - 900,000 ha (30 - 90 %) 30,000 - 54,000 ha (2 - 11 %)	<30% BHC 30-70% MUL <30% SSD <30% BBS	>70% Western	Nocoleche NR+ Paroo-Darling NP# + Culgoa NP# + Narran Lake NR# Toorale NP# +	71,162 176,413 36,520 28,397 91,527	3,600 30,000 1,500 2,000 5,000	0.36 3.00 0.15 0.20 0.50	E3 E2 E3 E2 E4
ASI	134: LC/3a: Ironwood woodland of the semi-arid plains	600,000 (420,000 - 780,000) ha 350,000 - 650,000 ha (58 - 110 %) 16,000 - 45,000 ha (2.1 - 11 %)	<30% CP <30% DRP 30-70% MUL <30% MDD <30% BBS <30% RIV	<30% Central West <30% Lachlan 30-70% Western	Gundabooka NP+ Nocoleche NR+ Yathong NR+ Narran Lake NR# Toorale NP# +	64,134 71,162 108,869 28,397 91,527	28,000 2,000 170 180 5,000	4.67 0.33 0.03 0.03 0.83	E2 E4 E2 E3 E4
ASI	135: E/5b: Cooba - Western Rosewood low open tall shrubland or woodland mainly on outwash areas in the BBS Bioregion	3,000 (1,500 - 4,500) ha 250 - 750 ha (8.3 - 25 %) 10 - 30 ha (0.22 - 2 %)	>70% BBS	30-70% Border R/Gwydir <30% Namoi <30% Central West	Warrumbungle NP	23,595	20	0.67	E3
ASI	372: NT/3e: Wattle low woodland/ tall shrubland on sandstone ridges in the northern NSW BBS Bioregion	200 (140 - 260) ha 120 - 200 ha (60 - 100 %) 26 - 140 ha (10 - 100 %)	>70% BBS	>70% Border R/Gwydir	Dthinna Dthinnawan NP Burral Yurrul NR Warialda SCA	27,819 1,341 2,908	50 30 5	25.0 15.0 2.50	E3 E4 E3
ASI	389: LC/1b: Motherumbah - White Bloodwood - cypress pine very tall shrubland / woodland of the Coonabarabran region, BBS Bioregion	1,500 (1,100 - 1,900) ha 840 - 1,500 ha (56 - 100 %) 680 - 820 ha (36 - 75 %)	>70% BBS	<30% Central West 30-70% Namoi	Warrumbungle NP Garrawilla NP	23,595 935	730 24	48.7 1.60	E1 M
ASI	390: NT/3c: Warrumbungle Currawang very tall shrubland	50 (35 - 65) ha 35 - 65 ha (70 - 130 %) 8 - 42 ha (12 - 120 %)	>70% BBS	30-70% Namoi	Warrumbungle NP	23,595	25	50.0	E3
ASI	445: CE/5b: Brigalow viney scrub open forest on loamy soils in low hill landscapes in the northern BBS Bioregion NSW	2,000 (1,000 - 3,000) ha 140 - 260 ha (7 - 13 %) 38 - 68 ha (1.3 - 6.8 %)	>70% BBS	>70% Border R/Gwydir	Planchonella NR Terry Hie Hie AA Bingara SCA Bullala NP	723 15,324 1,971 5,869	2 41 5 5	0.10 2.05 0.25 0.25	E4 E3 E1 E3
ASI	476: NT/5c: Narrow-leaved Wattle low open forest / very tall shrubland on ridges in northern NSW SWS and southern BBS Bioregions	400 (280 - 520) ha 210 - 390 ha (53 - 98 %) 6 - 10 ha (1.1 - 3.6 %)	30-70% BBS 30-70% NSS	>70% Central West <30% Hunter/Central R	Dapper NR**	1,101	8	2.00	E4
ASI	629: V/5b: Brigalow - Bladder Saltbush open woodland to tall open shrubland in the Come-By-Chance region, DRP and BBS Bioregions	7,000 (4,900 - 9,100) ha 2,800 - 5,200 ha (40 - 74 %) 0 ha	30-70% BBS 30-70% DRP	>70% Namoi	Not Protected				
AST	430: NT/4c: Motherumbah - red gum - White Cypress Pine tall shrubland of the Narrabri to Warialda region, BBS bioregion	200 (140 - 260) ha 91 - 160 ha (46 - 80 %) 14 - 26 ha (5.4 - 19 %)	>70% BBS	<30% Namoi >70% Border R/Gwydir	Couradda NP Moema NP Bullawa Creek SCA	362 2,024 99	15 5 1	7.50 2.50 0.50	M E4 E3

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CCI	055: E/5a: Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions	350,000 (250,000 - 450,000) ha 42,000 - 78,000 ha (12 - 22 %) 890 - 1,600 ha (0.2 - 0.64 %)	<30% BBS <30% CP 30-70% DRP <30% NSS	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western <30% Lachlan	Boronga NR#	198	20	0.01	E2
					Budelah NR#	4,055	1	<0.01	M
					Careunga NR	493	395	0.11	M
					Kirramingly NR	1,331	5	<0.01	E2
					Macquarie Marshes NR#	21,920	30	0.01	M
					Wilbertroy FR**	1,562	6	<0.01	M
					Boomi NR#	158	20	0.01	E2
					Boomi West NR#	149	15	<0.01	E2
					Brigalow Park NR	252	15	<0.01	M
					Pilliga West NP	8,005	62	0.02	E1
					Pilliga SCA	33,289	73	0.02	M
					Pilliga NP	10,606	270	0.08	M
					Pilliga West SCA#	36,241	155	0.04	E1
					Leard SCA	1,175	50	0.01	E2
					Gwydir Wetlands SCA# +	4,292	128	0.04	M
					VCA0008**	400	25	0.01	M
CCI	084: NT/3a: River Oak - Rough-barked Apple - red gum - box riparian tall woodland (wetland) of the Brigalow Belt South and Nandewar Bioregions	20,000 (14,000 - 26,000) ha 8,400 - 15,000 ha (42 - 75 %) 930 - 1,700 ha (3.6 - 12 %)	30-70% BBS 30-70% NAN	<30% Border R/Gwydir <30% Central West <30% Namoi	Kings Plains NP	8,228	140	0.70	E1
					Mount Kaputar NP	51,349	800	4.00	E1
					Severn River NR	5,847	150	0.75	E1
					Warrumbungle NP	23,595	90	0.45	M
					Moema NP	2,024	13	0.07	M
					Terry Hie Hie AA	15,324	60	0.30	E2
					Horton Falls NP	260	26	0.13	M
					Coolah Tops NP	16,220	20	0.10	E4
					GN9901 PA	474	29	0.15	M
CCI	228: V/5b: Semi-mesic woodland on basalt hills of the dry subtropical climate zone, north western slopes of NSW	6,000 (3,000 - 9,000) ha 1,300 - 3,700 ha (22 - 62 %) 0 ha	30-70% BBS <30% DRP	30-70% Border R/Gwydir <30% Central West	Not Protected				
CCI	373: LC/1a: Narrow-leaved Ironbark - White Cypress Pine -/+ Buloke tall open forest or woodland of the Warialda to Yetman region, BBS Bioregion	20,000 (14,000 - 26,000) ha 8,400 - 15,000 ha (42 - 75 %) 6,000 - 11,000 ha (23 - 79 %)	>70% BBS	>70% Border R/Gwydir <30% Namoi	Dthinna Dthinnawan NP	27,819	5,000	25.0	E1
					Dthinna Dthinnawan NR#	2,009	392	1.96	M
					Killarney SCA	1,857	674	3.37	M
					Burral Yurrul NR	1,341	100	0.50	E4
					Taringa NR	1,343	90	0.45	E3
					Bullala NP	5,869	1,763	8.82	E1
					Warialda SCA	2,908	500	2.50	E3

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CCI	378: E/5b: Belah - Wilga -+ White Box dry viney scrub woodland the NSW BBS Bioregion	4,000 (2,000 - 6,000) ha 500 - 1,500 ha (13 - 38 %) 120 - 200 ha (2 - 10 %)	>70% BBS	>70% Border R/Gwydir <30% Namoi	Couradda NP Moema NP Planchonella NR Bullala NP Terry Hie Hie AA	362 2,024 723 5,869 15,324	6 55 24 30 45	0.15 1.38 0.60 0.75 1.13	M M M E3 M
CCI	411: NT/2b: Buloke - White Cypress Pine woodland on outwash plains in the Pilliga Scrub and Narrabri regions. BBS bioregion	4,000 (2,000 - 6,000) ha 1,500 - 4,500 ha (38 - 110 %) 1,100 - 1,800 ha (18 - 90 %)	>70% BBS	>70% Namoi	Pilliga NP Pilliga SCA Killarney SCA Bullawa Creek SCA Pilliga NR	10,606 33,289 1,857 99 85,354	670 10 674 1 100	16.8 0.25 16.9 0.03 2.50	E2 E2 E1 M E3
CCI	449: V/4c: Stringybark She Oak - Narrow-leaved Ironbark - sticky mintbush low woodland in the northern NSW BBS Bioregion	200 (140 - 260) ha 120 - 220 ha (60 - 110 %) 28 - 34 ha (11 - 24 %)	>70% BBS	>70% Border R/Gwydir	Bullala NP	5,869	31	15.5	M
CCI	485: V/5b: River Oak riparian grassy tall woodland of the western Hunter Valley (BBS and Sydney Basin Bioregions)	2,000 (1,400 - 2,600) ha 700 - 1,300 ha (35 - 65 %) 28 - 50 ha (1.1 - 3.6 %)	>70% BBS <30% SB	>70% Hunter/Central R	Goulburn River NP*	73,445	39	1.95	M
CHS	168: NT/4a: Derived Copperburr shrubland of the NSW northern inland alluvial floodplains	50,000 (25,000 - 75,000) ha 65,000 - 190,000 ha (130 - 380 %) 350 - 1,000 ha (0.47 - 4 %)	<30% BBS >70% DRP	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Kirramingly NR Budelah NR#	1,331 4,055	185 500	0.37 1.00	E1 E3
CHS	195: E/5a: Bladder Saltbush chenopod shrubland on alluvial plains mainly in the Darling Riverine Plain Bioregion	80,000 (56,000 - 100,000) ha 5,600 - 10,000 ha (7 - 13 %) 300 - 300 ha (0.3 - 0.54 %)	>70% DRP <30% MUL <30% BBS	<30% Border R/Gwydir <30% Central West <30% Namoi 30-70% Western	Toorale NP# +	91,527	300	0.38	E4
CHS	211: V/4b: Slender Saltbush - samphire - copperburr low open shrubland wetland on irreguarly inundated floodplains mainly in the Darling Riverine Plains and BBS Bioregions	8,000 (4,000 - 12,000) ha 1,500 - 4,500 ha (19 - 56 %) 470 - 570 ha (3.9 - 14 %)	>70% DRP <30% BBS	<30% Border R/Gwydir <30% Central West <30% Namoi 30-70% Western	Narran Lake NR# Toorale NP# +	28,397 91,527	20 500	0.25 6.25	E1 E4
CHS	377: NT/3b: Copperburr low open shrubland on loam - clay flats and playas in the western BBS and northern DRP Bioregions	8,000 (4,000 - 12,000) ha 2,000 - 6,000 ha (25 - 75 %) 1,100 - 1,900 ha (9.2 - 48 %)	<30% BBS >70% DRP	<30% Border R/Gwydir 30-70% Western	Narran Lake NR#	28,397	1,500	18.8	E1
CHS	466: LC/5a: Galvanized Burr derived low shrubland of the BBS and DRP Bioregions	100 (50 - 150) ha 10,000 - 30,000 ha (10000 - 30000 %) 0 ha	<30% BBS 30-70% DRP <30% MUL <30% CP	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Not Protected				

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CPW	070: V/5a: White Cypress Pine woodland on sandy loams in central NSW wheatbelt	200,000 (100,000 - 300,000) ha 35,000 - 100,000 ha (18 - 50 %) 28 - 52 ha (0.0093 - 0.052 %)	<30% BBS <30% CP <30% DRP <30% MDD 30-70% NSS	30-70% Central West 30-70% Lachlan <30% Namoi	Strahorn FR# **	2,255	40	0.02	E2
CPW	376: E/5e: Mixed scrub low open woodland on sand rises and dunes on floodplains in the DRP & BBS Bioregions	700 (350 - 1,000) ha 100 - 300 ha (14 - 43 %) 100 - 100 ha (10 - 29 %)	30-70% DRP 30-70% BBS	30-70% Western <30% Border R/Gwydir	Narran Lake NR#	28,397	100	14.3	E2
CPW	396: LC/3a: White Cypress Pine - Narrow-leaved Ironbark - White Bloodwood - red gum shrub grass woodland of the Pilliga - Coonabarabran region, BBS Bioregion	30,000 (21,000 - 39,000) ha 16,000 - 28,000 ha (53 - 93 %) 1,000 - 3,000 ha (2.6 - 14 %)	>70% BBS	>70% Namoi	Yarragin NP Pilliga NR	3,122 85,354	1,500 500	5.00 1.67	E3 E4
CPW	418: LC/1a: White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, BBS Bioregion	16,000 (8,000 - 24,000) ha 6,000 - 18,000 ha (38 - 110 %) 8,700 - 10,000 ha (36 - 130 %)	>70% BBS <30% NAN	<30% Namoi 30-70% Border R/Gwydir	Moema NP Bobbiwaa SCA Gunyerwarildi NP Terry Hie Hie AA	2,024 2,676 316 15,324	237 310 230 8,800	1.48 1.94 1.44 55.0	M M M E1
CPW	431: LC/4b: White Bloodwood - Dirty Gum - cypress pine shrubby low woodland on sandy soils in the Narrabri to Warialda region, BBS Bioregion	6,000 (4,200 - 7,800) ha 3,500 - 6,500 ha (58 - 110 %) 420 - 760 ha (5.4 - 18 %)	>70% BBS	30-70% Border R/Gwydir <30% Namoi	Bobbiwaa SCA	2,676	590	9.83	E2
CPW	458: LC/1a: White Cypress Pine - Buloke - White Box shrubby open forest on hills in the Liverpool Plains - Dubbo region, BBS Bioregion	10,000 (7,000 - 13,000) ha 4,900 - 9,100 ha (49 - 91 %) 3,000 - 5,400 ha (23 - 77 %)	>70% BBS	30-70% Namoi 30-70% Central West	Goonoo NP Goonoo SCA Trinkey SCA	9,054 56,214 10,208	40 560 3,600	0.40 5.60 36.0	E4 E3 E2
CPW	463: NT/5e: White Cypress Pine - red gum grass-shrub woodland on sandstone hills of the Caroona region, Liverpool Plains, BBS Bioregion	1,000 (300 - 1,700) ha 240 - 1,300 ha (24 - 130 %) 0 ha	>70% BBS	>70% Namoi	Not Protected				
CPW	469: NT/1a: White Cypress Pine - Narrow-leaved Ironbark - Buloke grassy open forest of the Dubbo region, southern BBS Bioregion	45,000 (32,000 - 58,000) ha 21,000 - 39,000 ha (47 - 87 %) 13,000 - 22,000 ha (22 - 69 %)	>70% BBS	>70% Central West	Biddon SCA Drillwarrina NP Breelong NP Goonoo NP Goonoo SCA Coolbaggie NR Mogriguy NP Beni SCA VCA0088	3,349 1,076 6,840 9,054 56,214 1,774 398 1,838 96	700 800 2,000 4,500 9,000 800 315 660 95	1.56 1.78 4.44 10.0 20.0 1.78 0.70 1.47 0.21	E2 E2 E2 E3 E3 E2 E2 E3 E2

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CPW	475: E/5e: White Cypress Pine - Buloke - Grey Box grassy eolian lunette grassy woodland in the southern BBS Bioregion	80 (40 - 120) ha 20 - 60 ha (25 - 75 %) 0 ha	>70% BBS	>70% Central West	Not Protected				
CPW	480: LC/2b: Black Cypress Pine - ironbark -/+ Narrow-leaved Wattle low open forest mainly on Narrabeen Sandstone in the Upper Hunter region of the Sydney Basin Bioregion	2,000 (1,000 - 3,000) ha 900 - 2,700 ha (45 - 140 %) 240 - 1,300 ha (8 - 130 %)	>70% SB <30% BBS	>70% Hunter/Central R	Goulburn River NP*	73,445	70	3.50	E1
					Durridgere SCA*	6,104	50	2.50	E3
					Wollemi NP*	500,843	500	25.0	E4
					Munghorn Gap NR*	6,140	100	5.00	E4
					Manobalai NR*	3,799	50	2.50	E4
CPW	610: LC/3c: Black Cypress Pine - Dwyer's Gum low woodland / open forest on rocky ridges mainly of the Nandewar Range	100 (30 - 170) ha 30 - 170 ha (30 - 170 %) 11 - 59 ha (6.5 - 200 %)	>70% NAN <30% BBS	>70% Namoi <30% Border R/Gwydir	Deriah AA	2,232	5	5.00	M
					Mount Kaputar NP	51,349	30	30.0	E4
CRF	486: NT/5b: River Oak moist riparian tall open forest of the upper Hunter Valley, including Liverpool Range	2,000 (1,400 - 2,600) ha 840 - 1,500 ha (42 - 75 %) 57 - 100 ha (2.2 - 7.1 %)	30-70% BBS <30% NET <30% NAN	>70% Hunter/Central R <30% Namoi	Coolah Tops NP	16,220	20	1.00	E3
					Towarri NP*	6,517	45	2.25	E1
					Crawney Pass NP	249	16	0.80	M
EBWC	618: E/5a: White Box x Grey Box - red gum - Rough-barked Apple grassy woodland on rich soils on hills in the upper Hunter Valley	15,000 (11,000 - 19,000) ha 2,800 - 5,200 ha (19 - 35 %) 61 - 110 ha (0.32 - 1 %)	<30% BBS >70% SB	>70% Hunter/Central R	Towarri NP*	6,517	86	0.57	M
EBWP	056: V/5a: Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW	450,000 (180,000 - 720,000) ha 70,000 - 130,000 ha (16 - 29 %) 210 - 380 ha (0.029 - 0.21 %)	<30% BBS <30% CP 30-70% DRP <30% NSS	30-70% Border R/Gwydir 30-70% Central West <30% Lachlan <30% Namoi <30% Western	Boronga NR#	198	10	<0.01	E3
					Macquarie Marshes NR#	21,920	200	0.04	M
					Boomi NR#	158	5	<0.01	E3
					Boomi West NR#	149	10	<0.01	E2
					Gamilaroi NR	118	4	<0.01	M
					Bobbiwaa SCA	2,676	50	0.01	M
					Killarney SCA	1,857	20	<0.01	E2
EBWP	081: E/4a: Western Grey Box - cypress pine shrub grass shrub tall woodland in the BBS Bioregion	45,000 (32,000 - 58,000) ha 7,000 - 13,000 ha (16 - 29 %) 820 - 1,500 ha (1.4 - 4.7 %)	>70% BBS	30-70% Central West 30-70% Namoi	Coolbaggie NR	1,774	10	0.02	E3
					Wongarbon NR	94	4	0.01	E3
					Goonoo NP	9,054	120	0.27	E3
					Goonoo SCA	56,214	1,000	2.22	E3
					Beni SCA	1,838	34	0.08	E1
EBWP	087: V/5a: Poplar Box - Coolabah floodplain woodland on light clay soil mainly in the Darling Riverine Plain Bioregion	600,000 (300,000 - 900,000) ha 100,000 - 300,000 ha (17 - 50 %) 3,100 - 5,500 ha (0.34 - 1.8 %)	>70% DRP <30% BBS	30-70% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Boomi West NR#	149	2	<0.01	M
					Budelah NR#	4,055	25	<0.01	M
					Culgoa NP# +	36,520	3,000	0.50	E2
					Narran Lake NR#	28,397	1,280	0.21	M

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EBWP	098: NT/4a: Poplar Box - White Cypress Pine - Wilga - Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains and BBS Bioregions	500,000 (350,000 - 650,000) ha 210,000 - 390,000 ha (42 - 78 %) 8,400 - 15,000 ha (1.3 - 4.3 %)	<30% DRP <30% MUL <30% BBS	<30% Border R/Gwydir <30% Central West <30% Lachlan <30% Namoi 30-70% Western	Boronga NR#	198	80	0.02	E2
					Culgoa NP# +	36,520	3,500	0.70	E1
					Narran Lake NR#	28,397	8,000	1.60	E2
					Midkin NR#	374	90	0.02	E2
					Boomi NR#	158	65	0.01	E2
					Boomi West NR#	149	20	<0.01	E3
					Gwydir Wetlands SCA# +	4,292	80	0.02	M
EBWP	101: E/5a: Poplar Box - Yellow Box - Western Grey Box grassy woodland on cracking clay soils mainly in the Liverpool Plains, BBS Bioregion	20,000 (14,000 - 26,000) ha 3,500 - 6.500 ha (18 - 33 %) 12 - 22 ha (0.046 - 0.16 %)	>70% BBS	>70% Namoi <30% Border R/Gwydir	Gunyerwarildi NP	316	17	0.09	M
EBWP	202: E/4a: Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions	10,000 (5,000 - 15,000) ha 1,800 - 3,200 ha (18 - 32 %) 68 - 200 ha (0.45 - 4 %)	>70% BBS <30% NAN	<30% Border R/Gwydir <30% Central West <30% Namoi	Dthinna Dthinnawan NP	27,819	5	0.05	E3
					Timallallie NP	39,277	10	0.10	E3
					Goonoo SCA	56,214	100	1.00	E3
					Goonoo NP	9,054	20	0.20	E4
EBWP	244: E/5a: Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt).	1,500,000 (1,100,000 - 1,900,000) ha 280,000 - 520,000 ha (19 - 35 %) 170 - 500 ha (0.0089 - 0.045 %)	<30% BBS 30-70% DRP <30% NSS	30-70% Border R/Gwydir <30% Central West <30% Lachlan <30% Namoi <30% Western	Boomi NR#	158	30	<0.01	E2
					Boomi West NR#	149	54	<0.01	E2
					Budelah NR#	4,055	22	<0.01	M
					Midkin NR#	374	190	0.01	M
					Boronga NR#	198	20	<0.01	E3
					NY9902 PA#	421	20	<0.01	M
EBWP	397: NT/1a: Poplar Box - White Cypress Pine shrub grass tall woodland of the Pilliga - Warialda region, BBS Bioregion	40,000 (28,000 - 52,000) ha 16,000 - 28,000 ha (40 - 70 %) 14,000 - 24,000 ha (27 - 86 %)	>70% BBS	<30% Border R/Gwydir >70% Namoi <30% Central West	Pilliga West NP	8,005	6,610	16.5	E1
					Pilliga West SCA#	36.241	11,225	28.1	E3
					Pilliga SCA	33,289	1,000	2.50	E2
					Gunyerwarildi NP	316	15	0.04	M
					Terry Hie Hie AA	15,324	30	0.08	E1
EBWT	148: NT/4b: Dirty Gum - Buloke - White Cypress Pine - ironbark shrubby woodland on deep sandy soils in the Liverpool Plains region of the BBS Bioregion	2,000 (1,800 - 2,200) ha 700 - 1,300 ha (35 - 65 %) 160 - 270 ha (7.3 - 15 %)	>70% BBS	<30% Border R/Gwydir 30-70% Namoi	Trinkey SCA	10,208	215	10.8	E3
EBWT	281: V/5a: Rough-Barked Apple - red gum - Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSWSWS and BBS Bioregions	150,000 (75,000 - 220,000) ha 35,000 - 65,000 ha (23 - 43 %) 510 - 1,500 ha (0.23 - 2 %)	>70% BBS <30% NSS	<30% Central West <30% Namoi <30% Hunter/Central R <30% Border R/Gwydir	Warrumbungle NP	23,595	880	0.59	E1
					Burral Yurrul NP	1,033	8	0.01	E3
					Burral Yurrul NR	1,341	50	0.03	E2
					Taringa NR	1,343	35	0.02	E2
					Yarrobil NP**	1,824	18	0.01	E2
					Goodiman SCA**	568	10	0.01	E3

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EBWT	374: V/3b: Grey Box - cypress pine - red gum woodland on deep sandy loam soil in northern NSW BBS Bioregion	4,000 (2,000 - 6,000) ha 1,000 - 3,000 ha (25 - 75 %) 520 - 950 ha (8.7 - 48 %)	>70% BBS	>70% Border R/Gwydir	Dthinna Dthinnawan NP Dthinna Dthinnawan NR#	27,819 2,009	720 17	18.0 0.43	E1 M
EBWT	380: LC/3c: Warrumbungle trachyte talus scree woodland	800 (720 - 880) ha 720 - 880 ha (90 - 110 %) 280 - 520 ha (32 - 72 %)	>70% BBS	30-70% Central West <30% Namoi	Warrumbungle NP	23,595	400	50.0	E2
EBWT	381: NT/5a: Rough-barked Apple - box - Sticky Daisy Bush - cough bush grass-shrub hillslope open forest in the BBS Bioregion	30,000 (27,000 - 33,000) ha 18,000 - 22,000 ha (60 - 73 %) 50 - 150 ha (0.15 - 0.56 %)	>70% BBS	30-70% Namoi 30-70% Central West	Warrumbungle NP	23,595	100	0.33	E3
EBWT	382: LC/3b: Warrumbungle mountains Nandewar Box - Yellow Box shrub grass open forest, BBS Bioregion	2,000 (1,800 - 2,200) ha 1,400 - 1,600 ha (70 - 80 %) 300 - 900 ha (14 - 50 %)	>70% BBS	30-70% Namoi <30% Central West	Warrumbungle NP	23,595	600	30.0	E3
EBWT	383: E/4b: Apple Box - Rough-barked Apple terrace flats woodland of the southern BBS Bioregion	2,000 (1,000 - 3,000) ha 280 - 820 ha (14 - 41 %) 45 - 250 ha (1.5 - 25 %)	>70% BBS	30-70% Central West 30-70% Namoi <30% Hunter/Central R	Warrumbungle NP Coolah Tops NP	23,595 16,220	100 50	5.00 2.50	E4 E2
EBWT	384: NT/4c: Norton's Box - stringybark - cough bush shrub - grass woodland on volcanic crests of the Warrumbungle Range, BBS Bioregion	1,000 (700 - 1,300) ha 560 - 1,000 ha (56 - 100 %) 75 - 420 ha (5.8 - 60 %)	>70% BBS	30-70% Namoi 30-70% Central West	Warrumbungle NP Coolah Tops NP	23,595 16,220	50 200	5.00 20.0	E4 E3
EBWT	393: NT/1a: White Box shrubby woodland of the western Liverpool Range, Warrumbungle Range and south-west Pilliga forests, BBS Bioregion	30,000 (21,000 - 39,000) ha 14,000 - 26,000 ha (47 - 87 %) 7,300 - 13,000 ha (19 - 62 %)	>70% BBS	>70% Namoi <30% Central West	Yarragin NP Warrumbungle NP Pilliga NR Coolah Tops NP	3,122 23,595 85,354 16,220	290 10,000 20 50	0.97 33.3 0.07 0.17	E1 E2 E4 E4
EBWT	412: V/4a: White Box - Black Cypress Pine shrubby hill woodland in the east Pilliga - Mendooran - Gulgong regions, mainly BBS Bioregion	20,000 (14,000 - 26,000) ha 11,000 - 13,000 ha (55 - 65 %) 140 - 400 ha (0.54 - 2.9 %)	>70% BBS <30% NSS	30-70% Namoi 30-70% Central West	Pilliga NR Dapper NR** Yarrobil NP**	85,354 1,101 1,824	150 20 100	0.75 0.10 0.50	E4 E4 E3
EBWT	420: NT/5a: Red Stringybark - Rough-barked Apple -/+ Norton's Box open forest on hillslopes in the Warrumbungle NP - Coolah regions	8,000 (5,600 - 10,000) ha 3,500 - 6,500 ha (44 - 81 %) 35 - 65 ha (0.35 - 1.2 %)	>70% BBS	30-70% Namoi 30-70% Central West	Warrumbungle NP	23,595	50	0.63	E3
EBWT	421: E/4b: Yellow Box - White Cypress Pine alluvial terrace flats grassy woodland in the Pilliga forests to Warialda region, BBS Bioregion	2,000 (1,000 - 3,000) ha 400 - 1,200 ha (20 - 60 %) 77 - 140 ha (2.6 - 14 %)	>70% BBS	>70% Namoi <30% Border R/Gwydir	Pilliga NR Pilliga East SCA Terry Hie Hie AA	85,354 24,575 15,324	50 50 10	2.50 2.50 0.50	E3 E3 E3
EBWT	433: CE/5a: White Box grassy woodland to open woodland on basalt flats and rises in the Liverpool Plains sub-region, BBS Bioregion	10,000 (7,000 - 13,000) ha 1,100 - 1,900 ha (11 - 19 %) 0 ha	>70% BBS	>70% Namoi	Not Protected				

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EBWT	434: E/4a: White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern BBS Bioregion	100,000 (50,000 - 150,000) ha 18,000 - 52,000 ha (18 - 52 %) 850 - 1,500 ha (0.57 - 3 %)	>70% BBS	30-70% Namoi <30% Central West	Coolah Tops NP Dapper NR**	16,220 1,101	1,200 5	1.20 0.01	E2 E4
EBWT	435: V/4a: White Box - White Cypress Pine shrub grass hills woodland in the BBS and Nandewar Bioregions	120,000 (84,000 - 150,000) ha 35,000 - 65,000 ha (29 - 54 %) 1,300 - 1,500 ha (0.87 - 1.8 %)	>70% BBS <30% NSS	30-70% Central West 30-70% Namoi <30% Border R/Gwydir	Wondoba SCA Garrawilla NP Binnaway NR Trinkey SCA Beni SCA Dowe NP	1,660 935 3,721 10,208 1,838 380	837 39 10 500 6 14	0.70 0.03 0.01 0.42 0.01 0.01	M M E3 E2 M M
EBWT	436: LC/5a: Derived Kurrajong grassy open woodland / isolated trees in the BBS and Nandewar Bioregions	100 (70 - 130) ha 21,000 - 39,000 ha (21000 - 39000 %) 0 ha	>70% BBS <30% NAN	<30% Border R/Gwydir <30% Central West <30% Hunter/Central R <30% Namoi	Not Protected				
EBWT	437: E/5a: Yellow Box grassy woodland on lower hillslopes and valley flats in the southern NSW BBS Bioregion	35,000 (25,000 - 45,000) ha 7,200 - 8,800 ha (21 - 25 %) 0 ha	>70% BBS	30-70% Namoi <30% Central West <30% Border R/Gwydir <30% Hunter/Central R	Not Protected				
EBWT	441: CE/5c: Carbeen - White Box +/- Silver-leaved Ironbark grassy tall woodland on basalt hills, BBS Bioregion	500 (250 - 750) ha 25 - 75 ha (5 - 15 %) 0 ha	>70% BBS	>70% Border R/Gwydir	Not Protected				
EBWT	461: V/5a: Tumbledown Gum woodland on hills in the northern NSW South-western Slopes and southern BBS Bioregions	40,000 (28,000 - 52,000) ha 18,000 - 22,000 ha (45 - 55 %) 28 - 82 ha (0.054 - 0.29 %)	30-70% NSS <30% BBS <30% SB	30-70% Central West <30% Hunter/Central R <30% Hawk/Nepean	Yarrobil NP** Goodiman SCA** Port Macquarie NP*	1,824 568 2,839	5 40 10	0.01 0.10 0.03	E4 E3 E3
EBWT	464: NT/5b: Red Stringybark - Kurrajong - mixed eucalypt grassy open forest of the Coonabarabran - Gulgong region in the BBS and NSW SWS Bioregions	4,000 (2,000 - 6,000) ha 1,300 - 3,700 ha (33 - 93 %) 0 ha	30-70% BBS 30-70% NSS	<30% Namoi >70% Central West	Not Protected				
EBWT	483: CE/5a: Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	20,000 (14,000 - 26,000) ha 1,400 - 2,600 ha (7 - 13 %) 0 ha	>70% BBS	>70% Hunter/Central R	Not Protected				
EBWT	488: V/5b: Silvertop Stringybark - Yellow Box +/- Norton's Box grassy woodland on basalt hills mainly on northern aspects of the Liverpool Range, BBS Bioregion	3,000 (2,100 - 3,900) ha 1,100 - 1,900 ha (37 - 63 %) 25 - 75 ha (0.64 - 3.6 %)	>70% BBS	30-70% Namoi 30-70% Central West	Coolah Tops NP	16,220	50	1.67	E3
EBWT	489: E/5b: Long-leaved Box +/- Norton's Box - red gum grassy woodland on hills in the southern BBS Bioregion	2,000 (1,400 - 2,600) ha 350 - 650 ha (18 - 33 %) 8 - 22 ha (0.29 - 1.6 %)	>70% BBS	>70% Namoi	Coolah Tops NP	16,220	15	0.75	E4

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EBWT	496: V/3a: Yellow Box - White Box - Silvertop Stringybark - Blakely's Red Gum grass shrub woodland mainly on the Liverpool Range, BBS Bioregion	20,000 (10,000 - 30,000) ha 4,000 - 12,000 ha (20 - 60 %) 970 - 1,700 ha (3.2 - 17 %)	>70% BBS	>70% Namoi <30% Central West <30% Hunter/Central R	Coolah Tops NP	16,220	1,200	6.00	E3
					Towarri NP*	6,517	100	0.50	E3
					Murrurundi Pass NP*	215	76	0.38	M
EBWT	501: E/5b: Bendemeer White Gum - Silvertop Stringybark - Rough-barked Apple +/- Moonbi Apple Box grassy open forest of the southern New England Tablelands Bioregion	6,000 (3,000 - 9,000) ha 500 - 1,500 ha (8.3 - 25 %) 110 - 190 ha (1.2 - 6.3 %)	>70% NET <30% NAN	<30% Border R/Gwydir <30% Hunter/Central R >70% Namoi	Wallabadah NR	1,134	86	1.43	E3
					Crawney Pass NP	249	61	1.02	E1
EBWT	508: V/4a: Blakely's Red Gum - Stringybark - Rough-barked Apple open forest of the Nandewar and western New England Tablelands Bioregions	58,300 (30,000 - 87,000) ha 16,000 - 29,000 ha (27 - 50 %) 630 - 1,100 ha (0.72 - 3.7 %)	<30% NAN >70% NET	30-70% Border R/Gwydir 30-70% Namoi	Ironbark NR+	1,653	275	0.47	M
					Mount Yarrowyck NR	584	86	0.15	E3
					The Basin NR	2,275	61	0.10	E3
					Watsons Creek NR	1,392	55	0.09	E3
					Stony Batter Creek NR+	563	61	0.10	E3
					NCT Rockview COV	1,925	86	0.15	E3
					VCA0100	704	269	0.46	E1
EBWT	509: E/4a: Blakely's Red Gum - White Cypress Pine - Rough-barked Apple grassy open forest of drainage lines of the northern Nandewar and New England Tablelands Bioregions	16,000 (12,000 - 20,000) ha 2,800 - 5,200 ha (18 - 33 %) 110 - 300 ha (0.55 - 2.5 %)	>70% NAN <30% NET	>70% Border R/Gwydir	Goonoowigal SCA+	1,053	5	0.03	E3
					Gwydir River SCA	3,961	54	0.34	E3
					Kwiambal NP	9,726	98	0.61	E3
					Kwiambal NP	9,726	44	0.28	M
EBWT	510: E/5a: Blakely's Red Gum - Yellow Box grassy woodland of the New England Tablelands Bioregion	155,000 (110,000 - 200,000) ha 23,000 - 41,000 ha (15 - 26 %) 340 - 620 ha (0.17 - 0.56 %)	<30% NAN >70% NET	30-70% Border R/Gwydir <30% Hunter/Central R <30% Namoi 30-70% Northern Rivers	Barayamal NP	178	45	0.03	E3
					Duval NR	243	1	<0.01	M
					Imbota NR	218	68	0.04	E1
					Indwarra NP	933	9	0.01	E3
					Kings Plains NP	8,228	258	0.17	M
					Mount Yarrowyck NR	584	20	0.01	E3
					Single NP	2,566	41	0.03	M
					Yina NR	98	40	0.03	E1
EBWT	513: E/5b: Candlebark - Ribbon Gum grassy woodland of the New England Tablelands Bioregion	10,000 (5,000 - 15,000) ha 750 - 2,200 ha (7.5 - 22 %) 0 ha	>70% NET	>70% Border R/Gwydir <30% Northern Rivers	Not Protected				
EBWT	516: E/5a: Grey Box grassy woodland or open forest of the Nandewar and New England Tablelands Bioregions	100,000 (50,000 - 150,000) ha 11,000 - 19,000 ha (11 - 19 %) 50 - 140 ha (0.033 - 0.28 %)	>70% NAN <30% NET	>70% Border R/Gwydir <30% Namoi <30% Northern Rivers	Currys Gap SCA+	220	90	0.09	E3
					NCT Euroka COV	1,672	2	<0.01	E3
					NCT Rockview COV	1,925	7	0.01	E3
EBWT	533: E/5a: New England Peppermint grassy woodland on granitic substrates of the New England Tablelands Bioregion	30,000 (15,000 - 45,000) ha 4,500 - 13,000 ha (15 - 43 %) 70 - 130 ha (0.16 - 0.87 %)	>70% NET	30-70% Border R/Gwydir <30% Namoi 30-70% Northern Rivers	Warra NP	2,021	100	0.33	M

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EBWT	534: CE/5a: New England Peppermint grassy woodland on sedimentary or basaltic substrates of the New England Tablelands Bioregion	50,000 (25,000 - 75,000) ha 3,500 - 6,500 ha (7 - 13 %) 52 - 96 ha (0.069 - 0.38 %)	>70% NET	30-70% Border R/Gwydir <30% Namoi 30-70% Northern Rivers	Booroolong NR	967	73	0.15	M
					Duval NR	243	1	<0.01	E1
EBWT	538: NT/4a: Rough-barked Apple - Blakely's Red Gum open forest of the Nandewar and western New England Tablelands Bioregions	60,000 (30,000 - 90,000) ha 17,000 - 49,000 ha (28 - 82 %) 630 - 1,100 ha (0.7 - 3.7 %)	30-70% NAN 30-70% NET	>70% Border R/Gwydir <30% Namoi	Goonoowigal SCA+	1,053	25	0.04	E3
					Ironbark NR+	1,653	406	0.68	M
					Linton NR	667	9	0.02	E3
					Torrington SCA	30,430	358	0.60	M
					Warrabah NP	5,216	85	0.14	E3
					NCT Rockview COV	1,925	1	<0.01	E3
					NCT Euroka COV	1,672	10	0.02	M
EBWT	539: E/5b: Rough-barked Apple - Cabbage Gum grassy woodland of the New England Tablelands Bioregion	2,000 (1,000 - 3,000) ha 100 - 300 ha (5 - 15 %) 42 - 78 ha (1.4 - 7.8 %)	30-70% NET 30-70% NNC <30% NAN	>70% Border R/Gwydir	Currys Gap SCA+	220	50	2.50	E2
					Gibraltar NR	161	10	0.50	E2
EBWT	541: V/4a: Silvertop Stringybark - Rough-barked Apple grassy open forest of southern Nandewar, southern New England Tablelands and NSW North Coast Bioregions	75,000 (38,000 - 110,000) ha 14,000 - 40,000 ha (19 - 53 %) 750 - 1,300 ha (0.68 - 3.4 %)	30-70% NAN <30% NET 30-70% NNC	<30% Border R/Gwydir <30% Hunter/Central R >70% Namoi	Indwarra NP	933	202	0.27	E3
					The Basin NR	2,275	22	0.03	E3
					Wallabadah NR	1,134	834	1.11	E3
EBWT	544: V/4a: Rough-barked Apple -/+ cypress pine +/- Blakely's Red Gum riparian open forest / woodland of the Nandewar and New England Tableland Bioregions	23,000 (12,000 - 34,000) ha 4,000 - 12,000 ha (17 - 52 %) 640 - 1,100 ha (1.9 - 9.2 %)	30-70% NAN 30-70% NET	30-70% Border R/Gwydir 30-70% Namoi <30% Northern Rivers	Barayamal NP	178	7	0.03	E3
					Goonoowigal SCA+	1,053	102	0.44	E3
					Linton NR	667	5	0.02	E3
					Melville Range NR	842	35	0.15	E3
					Mount Kaputar NP	51,349	485	2.11	E3
					Severn River NR	5,847	48	0.21	E3
					Torrington SCA	30,430	210	0.91	E3
					Warialda SCA	2,908	10	0.04	E3
					Terry Hie Hie AA	15,324	36	0.16	M
EBWT	545: V/4b: Round-leaved Gum - Broad-leaved Stringybark grassy forest on metasediments in the Torrington area of the New England Tablelands Bioregion	1,700 (1,200 - 2,200) ha 980 - 1,800 ha (58 - 110 %) 140 - 260 ha (6.4 - 22 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA	30,430	200	11.8	E2
EBWT	565: NT/5a: Silvertop Stringybark - Mountain Gum grassy open forest of the New England Tablelands Bioregion	45,000 (32,000 - 58,000) ha 18,000 - 32,000 ha (40 - 71 %) 270 - 490 ha (0.47 - 1.5 %)	>70% NET	30-70% Border R/Gwydir <30% Namoi 30-70% Northern Rivers	Booroolong NR	967	190	0.42	M
					Duval NR	243	183	0.41	M
					VCA0083	209	5	0.01	E3
EBWT	567: V/5a: Broad-leaved Stringybark - Yellow Box shrub/grass open forest of the New England Tablelands Bioregion	47,000 (33,000 - 61,000) ha 13,000 - 23,000 ha (28 - 49 %) 280 - 500 ha (0.46 - 1.5 %)	<30% NAN >70% NET	30-70% Border R/Gwydir <30% Namoi 30-70% Northern Rivers	Avondale SCA	314	5	0.01	E3
					Booroolong NR	967	242	0.51	M
					Duval NR	243	14	0.03	M
					Imbota NR	218	100	0.21	E1
					VCA0028	50	30	0.06	E2

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EBWT	571: E/5a: Ribbon Gum - Rough-barked Apple - Yellow Box grassy woodland of the New England Tablelands and North Coast Bioregions	54,000 (27,000 - 81,000) ha 6,000 - 18,000 ha (11 - 33 %) 11 - 19 ha (0.014 - 0.07 %)	<30% NAN >70% NET <30% NNC	30-70% Border R/Gwydir <30% Hunter/Central R <30% Namoi 30-70% Northern Rivers	Imbota NR	218	10	0.02	M
					VCA0028	50	5	0.01	E3
EBWT	589: E/5a: White Box - White Cypress Pine - Silver-leaved Ironbark grassy woodland on mainly clay loam soils on hills mainly in the Nandewar Bioregion	290,000 (210,000 - 370,000) ha 35,000 - 65,000 ha (12 - 22 %) 630 - 1,100 ha (0.17 - 0.52 %)	>70% NAN <30% NET <30% BBS	<30% Border R/Gwydir >70% Namoi	Barayamal NP	178	123	0.04	E3
					Dowe NP	380	355	0.12	M
					Gwydir River NP	4,408	37	0.01	E3
					Indwarra NP	933	13	<0.01	E3
					Kwiambal NP	9,726	18	0.01	E3
					Somerton NP	757	232	0.08	E3
					Warrabah NP	5,216	5	<0.01	E3
					Burral Yurrul NP	1,033	50	0.02	E3
					Gunyerwarildi NP	316	54	0.02	M
					VCA0103	11	5	<0.01	E1
					VCA0090	1	1	<0.01	M
EBWT	590: E/5a: White Box grassy woodland on the Inverell basalts mainly in the Nandewar Bioregion	138,000 (97,000 - 170,000) ha 13,000 - 22,000 ha (9.4 - 16 %) 17 - 29 ha (0.01 - 0.03 %)	>70% NAN <30% NET <30% BBS	>70% Border R/Gwydir	Kings Plains NP	8,228	23	0.02	E1
EBWT	597: NT/3a: White Box - cypress pine - Silver-leaved Ironbark shrub grass open forest / woodland of the northern Brigalow Belt South and Nandewar Bioregions	81,000 (57,000 - 100,000) ha 25,000 - 45,000 ha (31 - 56 %) 6,300 - 11,000 ha (6.3 - 19 %)	>70% NAN <30% BBS	>70% Border R/Gwydir <30% Namoi	Bingara SCA	1,971	700	0.86	E2
					Gwydir River NP	4,408	43	0.05	E3
					Kelvin AA	2,263	392	0.48	E3
					Mount Kaputar NP	51,349	4,100	5.06	E2
					Somerton NP	757	73	0.09	E3
					Terry Hie Hie AA	15,324	718	0.89	E2
					Warialda NP	1,602	963	1.19	E3
					Warialda SCA	2,908	785	0.97	E2
					Warrabah NP	5,216	23	0.03	E3
					Planchonella NR	723	280	0.35	M
					Arakoola NR	3,164	200	0.25	E4
					Taringa NR	1,343	600	0.74	E3
					NCT Bora Creek COV	481	8	0.01	E3
EBWT	599: E/5a: Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South and Nandewar Bioregions	150,000 (110,000 - 190,000) ha 21,000 - 39,000 ha (14 - 26 %) 73 - 130 ha (0.038 - 0.12 %)	>70% NAN <30% NET <30% BBS	30-70% Border R/Gwydir 30-70% Namoi	Kwiambal NP	9,726	30	0.02	E3
					Mount Kaputar NP	51,349	41	0.03	E2
					Severn River NR	5,847	21	0.01	E3
					Terry Hie Hie AA	15,324	11	0.01	E1
EBWT	606: E/5b: Mountain Gum - Ribbon Gum open forest of drainage lines of the southern New England Tablelands Bioregion	3,000 (1,500 - 4,500) ha 250 - 750 ha (8.3 - 25 %) 39 - 71 ha (0.87 - 4.7 %)	>70% NET	30-70% Border R/Gwydir 30-70% Namoi	Aberbaldie NR	285	55	1.83	E2

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EBWT	608: V/5c: Mountain Gum - Blakely's Red Gum open forest on metasediments of the Torrington area of the New England Tablelands Bioregion	300 (210 - 390) ha 110 - 190 ha (37 - 63 %) 5 - 15 ha (1.3 - 7.1 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA	30,430	10	3.33	E4
ECT	490: LC/1a: Silvertop Stringybark - Forest Ribbon Gum very tall moist open forest on basalt plateau on the Liverpool Range, BBS Bioregion	25,000 (18,000 - 32,000) ha 13,000 - 23,000 ha (52 - 92 %) 7,600 - 9,200 ha (24 - 51 %)	>70% BBS	30-70% Namoi 30-70% Hunter/Central R <30% Central West	Towarri NP* Coolah Tops NP Cedar Brush NR	6,517 16,220 206	1,000 7,350 20	4.00 29.4 0.08	E3 E2 E4
ECT	491: LC/2b: Forest Ribbon Gum - Silvertop Stringybark - Mountain Gum tall open forest on basalt on the Liverpool Range, mainly BBS Bioregion	10,000 (7,000 - 13,000) ha 5,600 - 10,000 ha (56 - 100 %) 3,100 - 5,700 ha (24 - 81 %)	>70% BBS <30% NNC	<30% Central West 30-70% Hunter/Central R 30-70% Namoi	Coolah Tops NP Towarri NP* Cedar Brush NR	16,220 6,517 206	4,000 290 100	40.0 2.90 1.00	E2 E3 E3
ECT	540: V/5b: Silvertop Stringybark - Ribbon Gum - Rough-barked Apple open forest on basalt hills of southern Nandewar, southern New England Tablelands and NSW North Coast Bioregions	9,000 (4,500 - 13,000) ha 2,800 - 5,200 ha (31 - 58 %) 170 - 300 ha (1.3 - 6.7 %)	30-70% NAN <30% NET 30-70% NNC	<30% Hunter/Central R >70% Namoi	Crawney Pass NP Wallabadah NR	249 1,134	44 191	0.49 2.12	M E3
ECT	554: E/5a: Ribbon Gum - Mountain Gum - Snow Gum grassy open forest or woodland of the New England Tablelands Bioregion	160,000 (120,000 - 200,000) ha 18,000 - 32,000 ha (11 - 20 %) 14 - 26 ha (0.007 - 0.022 %)	<30% NAN >70% NET	30-70% Border R/Gwydir <30% Hunter/Central R <30% Namoi 30-70% Northern Rivers	Little Llangothlin NR Ngulin NR	255 1,242	17 3	0.01 <0.01	M M
ECT	572: NT/3c: Silvertop Stringybark - Bendemeer White Gum - Ribbon Gum open forest in the Kaputar area of the Nandewar Bioregion	800 (560 - 1,000) ha 350 - 650 ha (44 - 81 %) 280 - 510 ha (28 - 91 %)	>70% NAN	30-70% Border R/Gwydir 30-70% Namoi	Mount Kaputar NP	51,349	394	49.3	E2
ECT	625: LC/4b: Forest Ribbon Gum - Silvertop Stringybark - Sweet Pittosporum - Monkey Gum moist tall open forest of the northern upper Hunter Valley escarpment	2,500 (1,300 - 3,700) ha 1,000 - 3,000 ha (40 - 120 %) 170 - 490 ha (4.6 - 38 %)	>70% NET 30-70% NNC <30% NAN	30-70% Hunter/Central R 30-70% Northern Rivers	Murrurundi Pass NP* Towarri NP*	215 6,517	27 300	1.08 12.0	M E4
EIFC	482: NT/3b: Mugga Ironbark - Black Cypress Pine shrub/grass open forest of the upper Hunter Valley, mainly Sydney Basin Bioregion	1,500 (1,100 - 1,900) ha 840 - 1,500 ha (56 - 100 %) 400 - 400 ha (21 - 36 %)	<30% BBS >70% SB	>70% Hunter/Central R	Durridgere SCA* Goulburn River NP*	6,104 73,445	200 200	13.3 13.3	E4 E4
EIFC	528: V/5b: Mugga Ironbark - Blakely's Red Gum open forest of the Nandewar and New England Tablelands Bioregions	9,000 (4,500 - 13,000) ha 2,000 - 6,000 ha (22 - 67 %) 190 - 330 ha (1.5 - 7.3 %)	>70% NAN <30% NET	30-70% Border R/Gwydir 30-70% Namoi	Bingara SCA Linton NR NCT Bora Creek COV	1,971 667 481	5 210 43	0.06 2.33 0.48	E4 E4 E3
EIFC	566: E/5a: Mugga Ironbark open forest of the New England Tablelands Bioregion	15,000 (7,500 - 22,000) ha 2,100 - 3,900 ha (14 - 26 %) 0 ha	<30% NAN 30-70% NET	>70% Border R/Gwydir <30% Namoi	Not Protected				

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EIFC	617: NT/4b: Narrow-leaved Ironbark - box - Mock Olive shrubby open forest mainly on basalt slopes over sandstone in the upper Hunter Valley. BBS and Sydney Basin Bioregions	1,800 (900 - 2,700) ha 450 - 1,300 ha (25 - 72 %) 91 - 160 ha (3.4 - 18 %)	>70% SB <30% BBS	>70% Hunter/Central R	Towarri NP*	6,517	130	7.22	E2
EIFC	623: V/5a: Narrow-leaved Ironbark -/+ Grey Box grassy woodland of the upper Hunter Valley, mainly Sydney Basin Bioregion	20,000 (10,000 - 30,000) ha 4,000 - 12,000 ha (20 - 60 %) 0 ha	<30% BBS >70% SB	>70% Hunter/Central R	Not Protected				
EIW	036: V/4a: River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	150,000 (110,000 - 190,000) ha 49,000 - 91,000 ha (33 - 61 %) 5,600 - 6,700 ha (2.9 - 6.1 %)	<30% BBS >70% DRP <30% MUL	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Budelah NR#	4,055	540	0.36	E2
					Culgoa NP# +	36,520	74	0.05	M
					Gundabooka NP+	64,134	500	0.33	E2
					Macquarie Marshes NR#	21,920	4,500	3.00	E2
					Narran Lake NR#	28,397	30	0.02	E2
					Paroo-Darling SCA# +	41,445	268	0.18	E1
					Paroo-Darling NP# +	176,413	250	0.17	E1
					VCA0022#	19	9	0.01	E1
EIW	037: V/4a: Black Box woodland wetland on NSW central and northern floodplains including the DRP and BBS Bioregions.	900,000 (630,000 - 1,100,000) ha 250,000 - 450,000 ha (28 - 50 %) 9,200 - 17,000 ha (0.84 - 2.7 %)	<30% CP >70% DRP <30% MUL <30% BBS	<30% Border R/Gwydir 30-70% Central West <30% Namoi <30% Western	Culgoa NP# +	36,520	4,000	0.44	E2
					Gundabooka NP+	64,134	500	0.06	E3
					Macquaric Marshes NR#	21,920	609	0.07	M
					Paroo-Darling NP# +	176,413	5,000	0.56	E2
					Paroo-Darling SCA# +	41,445	2,000	0.22	E2
					Narran Lake NR#	28,397	50	0.01	E3
					Toorale NP# +	91,527	5,000	0.56	E4
EIW	040: E/4a: Coolabah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains	800,000 (560,000 - 1,000,000) ha 210,000 - 390,000 ha (26 - 49 %) 29,000 - 52,000 ha (2.9 - 9.3 %)	<30% BBS >70% DRP <30% MUL	30-70% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Boomi NR#	158	5	<0.01	E2
					Boomi West NR#	149	3	<0.01	E1
					Budelah NR#	4,055	1,530	0.19	E1
					Culgoa NP# +	36,520	6,500	0.81	E2
					Gundabooka NP+	64,134	1,000	0.13	E3
					Macquarie Marshes NR#	21,920	395	0.05	M
					Midkin NR#	374	10	<0.01	M
					Narran Lake NR#	28,397	570	0.07	E2
					Paroo-Darling NP# +	176,413	2,000	0.25	E2
					Paroo-Darling SCA# +	41,445	2,000	0.25	E3
					Toorale NP# +	91,527	25,000	3.13	E4
					Gwydir Wetlands SCA# +	4,292	1,000	0.13	E1

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EIW	078: V/4a: River Red Gum riparian tall woodland / open forest wetland in the Nandewar and BBS Bioregions	25,000 (18,000 - 32,000) ha 7,000 - 13,000 ha (28 - 52 %) 160 - 470 ha (0.5 - 2.6 %)	30-70% BBS 30-70% NAN	<30% Border R/Gwydir <30% Central West <30% Namoi	Kwiambal NP	9,726	173	0.69	M
					Wongarbon NR	94	14	0.06	E1
					Warrumbungle NP	23,595	15	0.06	E4
					Bobbiwaa SCA	2,676	32	0.13	M
					Arakoola NR	3,164	34	0.14	M
					Terry Hie Hie AA	15,324	40	0.16	E4
					Bingara SCA	1,971	6	0.02	M
EIW	206: V/4a: Dirty Gum - White Cypress Pine tall woodland of alluvial sand (sand monkeys) in the Darling Riverine Plain and BBS Bioregions	30,000 (21,000 - 39,000) ha 11,000 - 19,000 ha (37 - 63 %) 760 - 1,400 ha (1.9 - 6.7 %)	30-70% BBS 30-70% DRP	<30% Border R/Gwydir <30% Central West 30-70% Namoi	Sandgate FR#	779	14	0.05	E4
					Pilliga West NP	8,005	870	2.90	E2
					Pilliga West SCA#	36,241	200	0.67	E2
EIW	249: V/5b: River Red Gum swampy woodland wetland on cowals (lakes) and associated flood channels in central NSW	7,000 (3,500 - 10,000) ha 1,800 - 5,200 ha (26 - 74 %) 56 - 100 ha (0.56 - 2.9 %)	<30% DRP 30-70% NSS <30% RIV <30% BBS	30-70% Central West <30% Lachlan <30% Murrumbidgee <30% Murray	Lake Urana NR+	302	9	0.13	M
					Wiesners Swamp NR**	102	70	1.00	E1
EIW	367: V/4b: Forest Red Gum x Blakely's Red Gum - box woodland of the Yetman region, BBS Bioregion	3,500 (1,800 - 5,200) ha 500 - 1,500 ha (14 - 43 %) 350 - 650 ha (6.7 - 36 %)	>70% BBS	>70% Border R/Gwydir	Dthinna Dthinnawan NP	27,819	500	14.3	E1
EIW	399: LC/3b: Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, BBS Bioregion	5,000 (3,500 - 6,500) ha 3,200 - 5,800 ha (64 - 120 %) 590 - 1,700 ha (9.1 - 49 %)	>70% BBS	<30% Central West 30-70% Namoi	Dandry Gorge AA	382	12	0.24	E3
					Pilliga West NP	8,005	2	0.04	E1
					Pilliga West SCA#	36,241	200	4.00	E1
					Pilliga East SCA	24,575	35	0.70	E2
					Pilliga NR	85,354	200	4.00	E3
					Pilliga SCA	33,289	200	4.00	E3
					Pilliga NP	10,606	100	2.00	E3
					Pilliga East SCA	24,575	200	4.00	E3
					Timallallie NP	39,277	100	2.00	E3
					Weetalibah NR	2,146	10	0.20	E3
					Tinkrameanah NP	967	5	0.10	M
					Trinkey SCA	10,208	54	1.08	M
					Coolbaggie NR	1,774	20	0.40	E2
					Goonoo SCA	56,214	30	0.60	E3
					Goonoo NP	9,054	10	0.20	E4
EIW	438: CE/5b: River Red Gum riparian tall woodland wetland on basaltic alluvial soils mainly in the Liverpool Plains sub-region, BBS Bioregion	3,000 (2,100 - 3,900) ha 420 - 780 ha (14 - 26 %) 0 ha	>70% BBS	>70% Namoi	Not Protected				

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E1W	454: CE/4a: River Red Gum grassy chenopod open tall woodland (wetland) on floodplain clay soil of the Darling Riverine Plain and western BBS Bioregions	30,000 (15,000 - 45,000) ha 2,500 - 7,500 ha (8.3 - 25 %) 1,100 - 1,900 ha (2.4 - 13 %)	30-70% BBS 30-70% DRP	30-70% Border R/Gwydir <30% Namoi <30% Central West	Macquarie Marshes NR#	21,920	1,500	5.00	E3
E1W	628: CE/5e: Carbeen -/+ Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	2,000 (1,000 - 3,000) ha 100 - 300 ha (5 - 15 %) 38 - 110 ha (1.3 - 11 %)	>70% DRP <30% BBS	30-70% Namoi 30-70% Border R/Gwydir	Budelah NR#	4,055	76	3.80	M
E1W1	192: NT/5a: Silver-leaved Ironbark - Poplar Box +/- Ironwood shrub - grass woodland on rises in the north-western plains of NSW	150,000 (110,000 - 190,000) ha 70,000 - 130,000 ha (47 - 87 %) 60 - 180 ha (0.032 - 0.16 %)	<30% BBS <30% DRP <30% MUL	30-70% Border R/Gwydir 30-70% Western	Midkin NR# Narran Lake NR#	374 28,397	20 100	0.01 0.07	E3 E4
E1W1	227: E/5b: Silver-leaved Ironbark - White Cypress Pine - Rough-barked Apple woodland on alluvial terraces in central-north NSW	8,000 (4,000 - 12,000) ha 750 - 2,200 ha (9.4 - 28 %) 0 ha	>70% DRP <30% BBS	<30% Border R/Gwydir 30-70% Central West <30% Namoi	Not Protected				
E1WI	255: V/4a: Mugga Ironbark - Buloke - Pillga Box - White Cypress Pine shrubby woodland on sandstone in the Dubbo region, south-western BBS Bioregion	5,000 (3,500 - 6,500) ha 1,800 - 3,200 ha (36 - 64 %) 120 - 140 ha (1.8 - 4 %)	>70% BBS <30% NSS	>70% Central West <30% Namoi	GL0002 PA	968	130	2.60	E1
E1W1	368: LC/2a: Smooth-barked Apple - cypress pine - Long-fruited Bloodwood - Dirty Gum shrubby open forest / woodland on sandstone hills in the Warialda to Bonshaw region, Brigalow Belt South and Nandewar Bioregions	35,000 (25,000 - 45,000) ha 21,000 - 39,000 ha (60 - 110 %) 6,100 - 7.300 ha (14 - 29 %)	>70% BBS <30% NAN	>70% Border R/Gwydir	Dthinna Dthinnawan NP Dthinna Dthinnawan NR# Burral Yurrul NP Burral Yurrul NR Arakoola NR	27,819 2,009 1,033 1,341 3,164	5,340 40 210 320 602	15.3 0.11 0.60 0.91 1.72	M M E2 E3 M
E1W1	394: NT/1a: Narrow-leaved Ironbark - cypress pine woodland on slopes and flats in the Coonabarabran - Pilliga Scrub regions	11,000 (7,700 - 14,000) ha 4,900 - 9,100 ha (45 - 83 %) 2,600 - 4,600 ha (19 - 60 %)	>70% BBS	<30% Central West 30-70% Namoi	Warrumbungle NP Timallallie NP	23,595 39,277	1,590 2,000	14.5 18.2	E2 E3

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EIWI	398: LC/1a: Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north BBS Bioregion	150,000 (110.000 - 190,000) ha 99,000 - 120,000 ha (66 - 80 %) 47,000 - 86,000 ha (25 - 78 %)	>70% BBS	>70% Namoi <30% Central West	Trinkey SCA	10,208	1,500	1.00	E2
					Pilliga West NP	8,005	250	0.17	E1
					Lanes Mill FR	731	190	0.13	E1
					Dandry Gorge AA	382	180	0.12	E2
					Pilliga NR	85,354	500	0.33	E4
					Pilliga SCA	33,289	18,280	12.2	E2
					Pilliga NP	10,606	7,000	4.67	E2
					Pilliga East SCA	24,575	2,700	1.80	E2
					Pilliga East AA	1,346	10	0.01	E3
					Timallallie NP	39,277	10,000	6.67	E3
					Pilliga West SCA#	36,241	17,000	11.3	E3
					Merriwindi SCA	1,713	1,010	0.67	E2
					Yarragin NP	3,122	670	0.45	E3
					Bobbiwaa SCA	2,676	1,284	0.86	E2
					Killarney SCA	1,857	800	0.53	M
					Terry Hie Hie AA	15,324	1,700	1.13	E1
					Trinkey SCA	10,208	3,220	2.15	E1
EIWI	402: NT/2b: Mugga Ironbark - White Cypress Pine - gum tall woodland on flats in the Pilliga forests and surrounding regions, BBS Bioregion	5,000 (3,500 - 6,500) ha 2,100 - 3,900 ha (42 - 78 %) 1,600 - 2,700 ha (25 - 77 %)	>70% BBS	30-70% Namoi	Pilliga SCA	33,289	1,000	20.0	E2
					Pilliga NR	85,354	1,000	20.0	E3
					Timallallie NP	39,277	50	1.00	E3
					Weetalibah NR	2,146	100	2.00	E3
EIWI	403: V/4b: Dapper Mugga Ironbark - Western Grey Box - Blakely's Red Gum - Black Cypress Pine grass shrub hill woodland (southern BBS Bioregion)	6,000 (4,200 - 7,800) ha 2,700 - 3,300 ha (45 - 55 %) 370 - 660 ha (4.7 - 16 %)	>70% BBS <30% SB	30-70% Central West <30% Namoi <30% Hunter/Central R	Dapper NR**	1,101	510	8.50	E2
					Yarrobil NP**	1,824	5	0.08	E3
EIWI	404: LC/2a: Red Ironbark - White Bloodwood - /+ Burrows Wattle heathy woodland on sandy soil in the Pilliga forests	23,000 (17,000 - 29,000) ha 15,000 - 27,000 ha (65 - 120 %) 4,100 - 4,900 ha (14 - 29 %)	>70% BBS	>70% Namoi	Pilliga SCA	33,289	1,300	5.65	E3
					Lanes Mill FR	731	36	0.16	E1
					Timallallie NP	39,277	3,000	13.0	E3
					Pilliga NR	85,354	200	0.87	E3
EIWI	413: NT/3a: Silver-leaved Ironbark - White Cypress Pine - box dry shrub grass woodland of the Pilliga Scrub - Warialda region, BBS Bioregion	8,000 (5,600 - 10,000) ha 3,500 - 6,500 ha (44 - 81 %) 460 - 850 ha (4.6 - 15 %)	>70% BBS	30-70% Namoi 30-70% Border R/Gwydir	Bullawa Creek SCA	99	90	1.13	E1
					Pilliga SCA	33,289	560	7.00	E1
					Couradda NP	362	5	0.06	E4

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EIWI	417: LC/2a: Black Cypress Pine - Narrow-leaved Ironbark - red gum +/- White Bloodwood shrubby open forest on hills of the southern Pilliga, Coonabarabran and Garawilla regions, BBS Bioregion	20,000 (14,000 - 26,000) ha 12,000 - 22,000 ha (60 - 110 %) 6,600 - 12,000 ha (25 - 86 %)	>70% BBS	30-70% Namoi 30-70% Central West	Pilliga NR	85,354	5,000	25.0	E3
					Binnaway NR	3,721	2,000	10.0	E1
					Weetalibah NR	2,146	634	3.17	E3
					Garrawilla NP	935	487	2.44	E3
					Tinkrameanah NP	967	125	0.63	E3
					Trinkey SCA	10,208	1,000	5.00	E1
					Wondoba SCA	1.660	70	0.35	M
EIWI	423: LC/1b: Blue-leaved Ironbark - Black Cypress Pine - Rough-barked Apple woodland mainly in the east Pilliga forests, BBS bioregion	8,000 (5,600 - 10,000) ha 5,300 - 9,700 ha (66 - 120 %) 2,600 - 7,600 ha (26 - 140 %)	>70% BBS	>70% Namoi	Pilliga NP	10,606	3,000	37.5	E3
					Pilliga East SCA	24.575	2,000	25.0	E3
					Garrawilla NP	935	70	0.88	M
EIWI	440: LC/2a: Red Stringybark - Narrow-leaved Ironbark - Black Cypress Pine - hill red gum sandstone woodland of southern NSW BBS Bioregion	35,000 (25,000 - 45,000) ha 17,000 - 29,000 ha (49 - 83 %) 3,800 - 6,800 ha (8.4 - 27 %)	>70% BBS	30-70% Central West <30% Namoi	Binnaway NR	3,721	1,660	4.74	E2
					Weetalibah NR	2,146	1,000	2.86	E3
					Goonoo SCA	56,214	1,000	2.86	E3
					Yarrobil NP**	1,824	270	0.77	E3
					Goodiman SCA**	568	200	0.57	E3
					Durridgere SCA*	6.104	1,170	3.34	E3
EIWI	443: NT/4e: Red Ironbark - sheoak shrubby woodland of the Yetman-Warialda region, northern NSW BBS Bioregion	300 (150 - 450) ha 130 - 370 ha (43 - 120 %) 29 - 87 ha (6.4 - 58 %)	30-70% BBS 30-70% NAN	>70% Border R/Gwydir	Burral Yurrul NP	1,033	8	2.67	E1
					Burral Yurrul NR	1,341	50	16.7	E4
EIWI	444: CE/5b: Silver-leaved Ironbark grassy tall woodland on clay-loam soils on plains in the BBS Bioregion	3,000 (1,500 - 4,500) ha 250 - 750 ha (8.3 - 25 %) 1 - 19 ha (0.022 - 1.3 %)	>70% BBS	>70% Border R/Gwydir <30% Namoi	Taringa NR	1,343	10	0.33	E4
EIWI	456: NT/4b: Narrow-leaved Ironbark - White Bloodwood - Red Stringybark woodland of the Garawilla - Liverpool Plains region, BBS Bioregion	4,000 (2,800 - 5,200) ha 1,400 - 2,600 ha (35 - 65 %) 240 - 430 ha (4.6 - 15 %)	>70% BBS	>70% Namoi	Tinkrameanah NP	967	36	0.90	M
					Garrawilla NP	935	300	7.50	E3
EIWI	459: NT/3b: Narrow-leaved Ironbark - cypress pine - White Box shrubby woodland in sedimentary hills of the Gunnedah region, BBS Bioregion	3,000 (2,100 - 3,900) ha 1,400 - 2,600 ha (47 - 87 %) 530 - 980 ha (14 - 47 %)	>70% BBS	>70% Namoi	Wondoba SCA	1,660	755	25.2	E1

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EIW1	467: LC/1a: Blue-leaved Ironbark - Black Cypress Pine shrubby sandstone open forest in the southern BBS Bioregion (including Goonoo)	90,000 (63,000 - 110,000) ha 53,000 - 97,000 ha (59 - 110 %) 26,000 - 48,000 ha (24 - 76 %)	>70% BBS	>70% Central West <30% Hunter/Central R	Durridgere SCA*	6,104	12	0.01	E3
					Breelong NP	6,840	1,000	1.11	E2
					Biddon SCA	3,349	300	0.33	E3
					Goonoo NP	9,054	3,500	3.89	E2
					Goonoo SCA	56,214	31,000	34.4	E2
					Coolbaggie NR	1,774	350	0.39	E2
					Yarindury FR	1,460	60	0.07	E1
					Biddon SCA	3,349	250	0.28	E1
					Drillwarrina NP	1,076	5	0.01	E1
					Coolbaggie NR	1,774	480	0.53	E2
					Yarrobil NP**	1,824	10	0.01	E4
					Goodiman SCA**	568	17	0.02	E3
EIW1	468: LC/1a: Narrow-leaved Ironbark - Black Cypress Pine +/- Blakely's Red Gum shrubby open forest on sandstone low hills in the southern BBS Bioregion (including Goonoo)	30,000 (21,000 - 39,000) ha 14,000 - 26,000 ha (47 - 87 %) 6,800 - 12,000 ha (17 - 57 %)	>70% BBS	>70% Central West	Goonoo SCA	56,214	4,800	16.0	E2
					Wongarbon NR	94	20	0.07	E3
					Biddon SCA	3,349	1,900	6.33	E3
					Breelong NP	6,840	1,700	5.67	E3
					Coolbaggie NR	1,774	200	0.67	E2
					Goonoo NP	9,054	400	1.33	E3
					Mogriguy NP	398	42	0.14	E1
					Beni SCA	1,838	600	2.00	E3
					VCA0133	39	38	0.13	E1
EIW1	470: NT/1a: Mugga Ironbark - Narrow-leaved Ironbark - Buloke - Black Cypress Pine shrub grass open forest in the Goonoo forests and surrounding region, southern BBS Bioregion	15,000 (11,000 - 19,000) ha 7,000 - 13,000 ha (47 - 87 %) 2,300 - 6,800 ha (12 - 62 %)	>70% BBS	>70% Central West	Wongarbon NR	94	30	0.20	E3
					Goonoo SCA	56,214	3,200	21.3	E2
					Goonoo NP	9,054	50	0.33	E3
					Biddon SCA	3,349	300	2.00	E3
					Breelong NP	6,840	440	2.93	E3
					Coolbaggie NR	1,774	15	0.10	E2
					Beni SCA	1,838	530	3.53	E3
EIW1	478: NT/3a: Red Ironbark - Black Cypress Pine - stringybark -/+ Narrow-leaved Wattle shrubby open forest on sandstone in the Gulgong - Mendooran region, southern BBS Bioregion	12,000 (8,400 - 15,000) ha 6,000 - 11,000 ha (50 - 92 %) 680 - 2,000 ha (4.5 - 24 %)	<30% NSS 30-70% BBS	>70% Central West <30% Hunter/Central R <30% Hawk/Nepean	Dapper NR**	1,101	30	0.25	E1
					Yarrobil NP**	1,824	1,000	8.33	E3
					Goodiman SCA**	568	250	2.08	E3
					Durridgere SCA*	6,104	70	0.58	E3
EIW1	527: E/5b: Mugga Ironbark - Black Cypress Pine shrubby open forest mainly in the Nandewar and northern BBS Bioregions	6,000 (3,000 - 9,000) ha 1,500 - 4,500 ha (25 - 75 %) 150 - 260 ha (1.7 - 8.7 %)	30-70% NAN <30% BBS	>70% Border R/Gwydir	Arakoola NR	3,164	100	1.67	E2
					Nullamanna NP	296	87	1.45	E3
					Terry Hie Hie AA	15,324	20	0.33	M

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EIWI	529: E/5b: Mugga Ironbark - stringybark shrubby open forest of the far southern Nandewar and New England Tablelands Bioregions	4,000 (1,200 - 6,800) ha 150 - 850 ha (3.8 - 21 %) 0 ha	>70% NAN <30% NET	>70% Namoi	Not Protected				
EIWI	531: LC/1b: Narrow-leaved Ironbark - Black Cypress Pine +/- Motherumbah woodland in the Kaputar area in the Nandewar Bioregion	10,000 (7,000 - 13,000) ha 5,600 - 10,000 ha (56 - 100 %) 4,400 - 8.000 ha (34 - 110 %)	30-70% NAN 30-70% BBS	30-70% Border R/Gwydir 30-70% Namoi	Mount Kaputar NP	51,349	4,500	45.0	E1
					Deriah AA	2.232	1.100	11.0	E1
					Terry Hie Hie AA	15.324	617	6.17	M
EIWI	532: LC/4b: Narrow-leaved Ironbark - Tumbledown Red Gum shrubby open forest in the Melville Range area of southern Nandewar Bioregion	5,500 (3,900 - 7,100) ha 3,800 - 6,800 ha (69 - 120 %) 470 - 860 ha (6.6 - 22 %)	>70% NAN	>70% Namoi	Melville Range NR	842	667	12.1	M
EIWI	592: NT/3a: Narrow-leaved Ironbark - cypress pine - White Box shrubby open forest in the Brigalow Belt South and Nandewar Bioregions	42,000 (30,000 - 54,000) ha 14,000 - 26,000 ha (33 - 62 %) 3,100 - 5,600 ha (5.7 - 19 %)	30-70% NAN 30-70% BBS	30-70% Namoi 30-70% Border R/Gwydir	Deriah AA	2,232	510	1.21	E2
					Kelvin AA	2,263	400	0.95	E3
					Mount Kaputar NP	51.349	2,820	6.71	E2
					Leard SCA	1,175	200	0.48	E3
					Terry Hie Hie AA	15.324	430	1.02	E1
EIWI	593: E/4a: Silver-leaved Ironbark - White Cypress Pine grassy woodland mainly in the northern Nandewar Bioregion	63,000 (45,000 - 81,000) ha 7,000 - 13,000 ha (11 - 21 %) 110 - 190 ha (0.14 - 0.42 %)	30-70% NAN 30-70% BBS	>70% Border R/Gwydir	Gibraltar NR	161	148	0.23	E2
EIWI	594: NT/4a: Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South and Nandewar Bioregions	120,000 (84,000 - 150,000) ha 40,000 - 72,000 ha (33 - 60 %) 3,700 - 6,700 ha (2.5 - 8 %)	>70% NAN <30% NET <30% BBS	>70% Border R/Gwydir <30% Namoi	Bingara SCA	1,971	200	0.17	E3
					Gwydir River NP	4,408	1,602	1.34	E3
					Gwydir River SCA	3,961	124	0.10	E3
					Kwiambal NP	9,726	564	0.47	E3
					Mount Kaputar NP	51,349	654	0.55	E2
					Burral Yurrul NR	1,341	160	0.13	E4
					Taringa NR	1,343	400	0.33	E3
					Warialda SCA	2,908	700	0.58	E3
					NCT Bora Creek COV	481	280	0.23	E3
					NCT Euroka COV	1.672	516	0.43	E1
EIWI	595: V/5a: Silver-leaved Ironbark - White Cypress Pine - tea tree shrubby woodland mainly in the northern Nandewar Bioregion	33,700 (24,000 - 43,000) ha 12,000 - 21,000 ha (36 - 62 %) 150 - 270 ha (0.35 - 1.1 %)	30-70% NAN <30% BBS	>70% Border R/Gwydir	Burral Yurrul NR	1,341	210	0.62	E3

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EMDI	141: LC/1a: Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, BBS Bioregion	14,000 (13,000 - 15,000) ha 12,000 - 13,000 ha (86 - 93 %) 4,300 - 7,800 ha (29 - 60 %)	>70% BBS	<30% Central West >70% Namoi	Timallallie NP	39,277	1,820	13.0	E1
					Pilliga NR	85,354	20	0.14	E1
					Lanes Mill FR	731	462	3.30	M
					Pilliga SCA	33,289	3,300	23.6	E1
					Pilliga East SCA	24,575	81	0.58	M
					Biddon SCA	3,349	62	0.44	E1
					Drillwarrina NP	1,076	4	0.03	M
					Breelong NP	6,840	150	1.07	E3
					Coolbaggie NR	1,774	3	0.02	E2
					Goonoo SCA	56,214	90	0.64	E4
					Goonoo NP	9,054	40	0.29	E3
					Mogriguy NP	398	28	0.20	E1
ESAW	494: LC/2b: Snow Gum - Mountain Gum - Silver Wattle tall open forest of the Liverpool Range, BBS Bioregion	3,000 (2,100 - 3,900) ha 1,400 - 2,600 ha (47 - 87 %) 830 - 1,500 ha (21 - 71 %)	<30% NAN 30-70% BBS <30% NNC	<30% Central West 30-70% Hunter/Central R 30-70% Namoi	Ben Halls Gap NP	3,058	100	3.33	E1
					Coolah Tops NP	16,220	875	29.2	E1
					Towarri NP*	6,517	210	7.00	M
ESAW	498: NT/3e: Black Sallee plateau low woodland in the southern BBS Bioregion	300 (210 - 390) ha 170 - 310 ha (57 - 100 %) 98 - 180 ha (25 - 86 %)	>70% BBS <30% NNC	30-70% Namoi 30-70% Hunter/Central R	Coolah Tops NP	16,220	140	46.7	E2
ESAW	507: E/5a: Black Sallee - Snow Gum grassy woodland of the New England Tablelands Bioregion	30,000 (15,000 - 45,000) ha 2,000 - 6,000 ha (6.7 - 20 %) 33 - 59 ha (0.073 - 0.39 %)	>70% NET	30-70% Northern Rivers <30% Namoi 30-70% Border R/Gwydir <30% Hunter/Central R	Cathedral Rock NP	11,065	19	0.06	E3
					Little Llangothlin NR	255	27	0.09	M
ESAW	525: LC/1b: Mountain Gum - Snow Gum grassy open forest at high altitudes in the Kaputar area of the Nandewar Bioregion	1,140 (1,100 - 1,200) ha 990 - 1,200 ha (87 - 110 %) 990 - 1,200 ha (83 - 110 %)	>70% NAN	30-70% Border R/Gwydir 30-70% Namoi	Mount Kaputar NP	51,349	1,100	96.5	E1

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ESWWS	088: LC/1a: Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the BBS Bioregion	40,000 (20,000 - 60,000) ha 13,000 - 37,000 ha (33 - 93 %) 12,000 - 20,000 ha (20 - 100 %)	>70% BBS <30% DRP	<30% Border R/Gwydir <30% Central West 30-70% Namoi	Brigalow Park NR	252	85	0.21	E2
					Terry Hie Hie AA	15,324	300	0.75	E3
					Gamilaroi NR	118	53	0.13	M
					Pilliga West NP	8,005	85	0.21	E1
					Timallallie NP	39,277	100	0.25	E2
					Trinkey SCA	10,208	250	0.63	E2
					Pilliga SCA	33,289	5,000	12.5	E2
					Pilliga NP	10,606	1,200	3.00	E2
					Pilliga East AA	1,346	30	0.08	E2
					Pilliga West SCA#	36,241	7,000	17.5	E2
					Merriwindi SCA	1,713	320	0.80	E2
					Yarragin NP	3,122	5	0.01	E1
					Bobbiwaa SCA	2,676	200	0.50	E1
					Killarney SCA	1,857	50	0.13	E3
					Bullala NP	5,869	30	0.08	E3
					Terry Hie Hie AA	15,324	10	0.03	E3
					Trinkey SCA	10,208	200	0.50	E2
					Biddon SCA	3,349	50	0.13	E1
					Drillwarrina NP	1,076	230	0.58	E2
					Breelong NP	6,840	650	1.63	E1
					Coolbaggie NR	96	4	0.01	E3
					VCA0088				E3
ESWWS	369: V/2c: Blakely's Red Gum - Smooth-barked Apple shrub swamp woodland on siliceous white sands in the Yetman region	40 (36 - 44) ha 32 - 38 ha (80 - 95 %) 26 - 30 ha (59 - 83 %)	>70% BBS	>70% Border R/Gwydir	Dthinna Dthinnawan NP	27,819	28	70.0	M
ESWWS	370: LC/2a: Black Cypress Pine - Dirty Gum - bloodwood - She Oak open forest on siliceous hills in the northern NSW BBS Bioregion	40,000 (28,000 - 52,000) ha 21,000 - 39,000 ha (53 - 98 %) 8,800 - 10,000 ha (17 - 36 %)	>70% BBS	>70% Border R/Gwydir	Dthinna Dthinnawan NP	27,819	8,820	22.1	M
					Dthinna Dthinnawan NR#	2,009	580	1.45	M
					Burral Yurrul NP	1,033	150	0.38	E3
					Burral Yurrul NR	1,341	200	0.50	E4
ESWWS	371: NT/1a: Silver-leaved Ironbark - cypress pine - Stringybark She Oak shrubby woodland in the Yetman - Warialda region, BBS Bioregion	12,000 (6,000 - 18,000) ha 4,000 - 12,000 ha (33 - 100 %) 5,500 - 6,700 ha (31 - 110 %)	30-70% BBS <30% NAN	>70% Border R/Gwydir	Dthinna Dthinnawan NP	27,819	6,000	50.0	E1
					Dthinna Dthinnawan NR#	2,009	100	0.83	E1
ESWWS	379: LC/1a: Inland Scribbly Gum - White Bloodwood - Red Stringybark - Black Cypress Pine shrubby sandstone woodland mainly of the Warrumbungle NP - Pilliga region in the BBS Bioregion	25,000 (23,000 - 27,000) ha 18,000 - 22,000 ha (72 - 88 %) 5,700 - 10,000 ha (21 - 43 %)	>70% BBS	30-70% Namoi 30-70% Central West	Warrumbungle NP	23,595	4,620	18.5	E2
					Pilliga NR	85,354	3,000	12.0	E2
					Pilliga East SCA	24,575	500	2.00	E3
					Timallallie NP	39,277	20	0.08	E4

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ESWWS	385: LC/3b: Warrumbungle trachyte hillcrest Tumbledown Red Gum - Black Cypress Pine - White Bloodwood shrubby woodland	8,000 (5,600 - 10,000) ha 3,500 - 6,500 ha (44 - 81 %) 1,300 - 2,300 ha (13 - 41 %)	>70% BBS	30-70% Central West 30-70% Namoi	Warrumbungle NP	23,595	1,800	22.5	E2
ESWWS	386: NT/2c: Tumbledown Red Gum trachyte rock flat sedgeland - shrubland of the Warrumbungle Range region	60 (54 - 66) ha 45 - 55 ha (75 - 92 %) 15 - 45 ha (23 - 83 %)	>70% BBS	>70% Namoi	Warrumbungle NP	23,595	30	50.0	E3
ESWWS	387: NT/5c: Tumbledown Red Gum - Porcupine Grass hummock grassland low open woodland on trachyte plugs in the Garawilla - Coolah region	300 (210 - 390) ha 180 - 320 ha (60 - 110 %) 0 ha	>70% BBS	>70% Namoi	Not Protected				
ESWWS	401: LC/1a: Rough-barked Apple - red gum - cypress pine woodland on sandy flats, mainly in the Pilliga Scrub region	18,000 (9,000 - 27,000) ha 6,000 - 18,000 ha (33 - 100 %) 5,900 - 10,000 ha (22 - 110 %)	>70% BBS	>70% Namoi <30% Central West	Pilliga NP	10,606	218	1.21	E1
					Timallallie NP	39.277	2,400	13.3	E2
					Pilliga NR	85,354	2,600	14.4	E2
					Pilliga SCA	33,289	400	2.22	E3
					Pilliga SCA	33,289	80	0.44	E3
					Pilliga NP	10,606	100	0.56	E3
					Pilliga East SCA	24,575	2,000	11.1	E3
					Pilliga East AA	1,346	10	0.06	E4
					Yarragin NP	3,122	3	0.02	E1
					Binnaway NR	3,721	50	0.28	E1
					Weetalibah NR	2,146	400	2.22	E3
					Trinkey SCA	10,208	100	0.56	E3
ESWWS	405: LC/1a: White Bloodwood - Red Ironbark - cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions	140,000 (130,000 - 150,000) ha 110,000 - 130,000 ha (79 - 93 %) 46,000 - 83,000 ha (31 - 64 %)	>70% BBS	>70% Namoi <30% Central West	Timallallie NP	39,277	16,820	12.0	E3
					Pilliga East SCA	24,575	11,460	8.19	E3
					Pilliga NR	85.354	35,000	25.0	E3
					Pilliga East AA	1,346	60	0.04	E2
					Pilliga SCA	33,289	500	0.36	E2
					Dandry Gorge AA	382	215	0.15	E3
					Lanes Mill FR	731	34	0.02	E4
					Yarragin NP	3,122	150	0.11	E3
					Burral Yurrul NP	1,033	8	0.01	E3
					Goonoo SCA	56.214	200	0.14	E4
ESWWS	406: LC/2b: White Bloodwood - Motherumbah - Red Ironbark shrubby sandstone hill woodland / open forest mainly in east Pilliga forests	8,000 (5,600 - 10,000) ha 5,300 - 9,700 ha (66 - 120 %) 1,300 - 3,700 ha (13 - 66 %)	>70% BBS	>70% Namoi	Pilliga East AA	1,346	200	2.50	E2
					Pilliga East SCA	24,575	250	3.13	E2
					Pilliga NR	85,354	2,000	25.0	E2
					Timallallie NP	39,277	50	0.63	E4
					Garrawilla NP	935	14	0.18	M

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ESWWS	407: LC/1a: White Bloodwood - ironbark - Black Cypress Pine shrubby sandstone hill woodland of the southern Pilliga forests	70,000 (49,000 - 91,000) ha 42,000 - 78,000 ha (60 - 110 %) 19,000 - 33,000 ha (21 - 67 %)	>70% BBS	>70% Namoi	Pilliga East AA	1,346	240	0.34	E2
					Pilliga East SCA	24,575	60	0.09	E2
					Pilliga NR	85,354	25,000	35.7	E3
					Timallallie NP	39,277	650	0.93	E3
					Dandry Gorge AA	382	155	0.22	E3
ESWWS	408: LC/1a: Dirty Gum (Baradine Gum) - Black Cypress Pine - White Bloodwood shrubby woodland on of the Pilliga forests and surrounding region	7,000 (4,900 - 9,100) ha 4,200 - 7,800 ha (60 - 110 %) 2,200 - 3,900 ha (24 - 80 %)	>70% BBS	>70% Namoi	Pilliga East SCA	24,575	300	4.29	E4
					Pilliga NR	85,354	2,000	28.6	E4
					Timallallie NP	39,277	500	7.14	E3
					Killarney SCA	1,857	200	2.86	E1
					Bullawa Creek SCA	99	6	0.09	E3
ESWWS	409: LC/1a: Dirty (Baradine) Gum - White Bloodwood - White Cypress Pine - Motherumbah shrubby woodland on sandy soils in the Pilliga Scrub and surrounding region, BBS Bioregion	30,000 (21,000 - 39,000) ha 18,000 - 32,000 ha (60 - 110 %) 8,400 - 15,000 ha (22 - 71 %)	>70% BBS	>70% Namoi <30% Border R/Gwydir	Yarragin NP	3,122	500	1.67	E3
					Moema NP	2,024	350	1.17	E2
					Pilliga SCA	33,289	1,500	5.00	E3
					Pilliga NP	10,606	500	1.67	E2
					Pilliga NR	85,354	2,000	6.67	E4
					Pilliga East SCA	24,575	5,000	16.7	E2
					Pilliga East AA	1,346	10	0.03	E4
					Timallallie NP	39,277	1,700	5.67	E3
					Merriwindi SCA	1,713	380	1.27	E2
ESWWS	419: LC/1c: Stringybark shrubby low woodland on sandstone ridges in the Pilliga Scrub, BBS Bioregion	200 (180 - 220) ha 180 - 220 ha (90 - 110 %) 90 - 110 ha (41 - 61 %)	>70% BBS	>70% Namoi	Pilliga NR	85,354	100	50.0	E3
ESWWS	422: LC/2b: Smooth-barked Apple - cypress pine - Narrow-leaved Ironbark - White Bloodwood tall heathy woodland of the Pilliga forests to Warialda region, BBS Bioregion	7,000 (4,900 - 9,100) ha 3,500 - 6,500 ha (50 - 93 %) 1,700 - 3,000 ha (19 - 61 %)	>70% BBS	30-70% Namoi 30-70% Border R/Gwydir	Pilliga East SCA	24,575	140	2.00	E1
					Pilliga NR	85,354	500	7.14	E3
					Moema NP	2,024	40	0.57	E3
					Couradda NP	362	101	1.44	M
					Bobbiwaa SCA	2,676	174	2.49	E1
					Killarney SCA	1,857	5	0.07	E4
					Terry Hie Hie AA	15,324	1,400	20.0	E1
ESWWS	428: E/4c: Carbeen - White Cypress Pine - Curracabah - White Box tall woodland on sand in the Narrabri - Warialda region of the BBS Bioregion	1,000 (700 - 1,300) ha 350 - 650 ha (35 - 65 %) 140 - 250 ha (11 - 36 %)	>70% BBS	30-70% Namoi <30% Border R/Gwydir	Killarney SCA	1,857	6	0.60	E1
					Bobbiwaa SCA	2,676	2	0.20	E3
					Bullala NP	5,869	187	18.7	M
ESWWS	429: NT/2a: White Cypress Pine - Poplar Box - Silver-leaved Ironbark viney shrub woodland of the BBS Bioregion	8,000 (4,000 - 12,000) ha 2,000 - 6,000 ha (25 - 75 %) 1,100 - 1,900 ha (9.2 - 48 %)	>70% BBS	>70% Border R/Gwydir <30% Namoi	Couradda NP	362	231	2.89	E1
					Moema NP	2,024	1,270	15.9	E1

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ESWWS	432: LC/3e: Dwyers Red Gum - Dirty (Baradine) Gum - cypress pine shrubby woodland of the Narrabri region of the BBS Bioregion	300 (150 - 450) ha 200 - 360 ha (67 - 120 %) 70 - 130 ha (16 - 87 %)	>70% BBS	>70% Namoi	Killarney SCA	1,857	100	33.3	E1
ESWWS	448: LC/2b: Smooth-barked Apple - Black Cypress Pine - Red Stringybark sandstone open forest in the Warialda to Arakoola region of the BBS Bioregion	3,000 (2,100 - 3,900) ha 1,800 - 3,200 ha (60 - 110 %) 950 - 1,700 ha (24 - 81 %)	>70% BBS <30% NAN	>70% Border R/Gwydir	Arakoola NR Warialda SCA	3,164 2,908	600 750	20.0 25.0	E2 E3
ESWWS	450: V/4b: Smooth-barked Apple - White Cypress Pine grass shrub woodland on lower slopes and sandy flats, north-western BBS Bioregion	1,500 (750 - 2,200) ha 300 - 900 ha (20 - 60 %) 150 - 170 ha (6.8 - 23 %)	>70% BBS	>70% Border R/Gwydir	Bullala NP	5,869	158	10.5	M
ESWWS	453: NT/5b: Granite gorge Tumbledown Red Gum - White Cypress Pine - Oleander Wattle low open woodland in the Warialda region	2,000 (1,000 - 3,000) ha 600 - 1,800 ha (30 - 90 %) 0 ha	30-70% NAN 30-70% BBS	>70% Border R/Gwydir	Not Protected				
ESWWS	455: V/5c: Rough-barked Apple - Red Stringybark - Black Cypress Pine - red gum sand valley woodland of the Garawilla region, BBS Bioregion	800 (400 - 1,200) ha 280 - 520 ha (35 - 65 %) 70 - 130 ha (5.8 - 33 %)	>70% BBS	>70% Namoi	Tinkrameanah NP	967	100	12.5	E1
ESWWS	457: LC/2b: White Bloodwood - Red Ironbark Black Cypress Pine woodland on sandstone hills in the Garawilla - Liverpool Plains region, BBS Bioregion	5,000 (3,500 - 6,500) ha 2,500 - 4,500 ha (50 - 90 %) 1,800 - 2,200 ha (28 - 63 %)	>70% BBS	>70% Namoi	Tinkrameanah NP Trinkey SCA	967 10,208	700 1,300	14.0 26.0	E1 E1
ESWWS	462: NT/5e: Dwyers Red Gum - White Cypress Pine - Motherumbah open forest / woodland on sandstone hillcrests in the Liverpool Plains region, BBS Bioregion	500 (350 - 650) ha 210 - 390 ha (42 - 78 %) 0 ha	>70% BBS	>70% Namoi	Not Protected				
ESWWS	471: LC/2b: Dwyers Red Gum - Black Cypress Pine - ironbark low woodland on sandstone hillcrests in the Dubbo - Gilgandra region, south-western BBS Bioregion	1,500 (1,100 - 1,900) ha 840 - 1,500 ha (56 - 100 %) 330 - 960 ha (17 - 87 %)	>70% BBS	>70% Central West	Goonoo NP Goonoo SCA Coolbaggie NR	9,054 56,214 1,774	75 500 70	5.00 33.3 4.67	E3 E3 E2
ESWWS	473: NT/3b: Red gum - Rough-barked Apple - Narrow-leaved Ironbark - cypress pine grassy open forest on flats and drainage lines in the Goonoo and surrounding forests, southern BBS Bioregion	5,000 (3,500 - 6,500) ha 2,500 - 4,500 ha (50 - 90 %) 910 - 1,600 ha (14 - 46 %)	>70% BBS	>70% Central West	Biddon SCA Goonoo SCA Goonoo NP Drillwarrina NP Breelong NP Beni SCA	3,349 56,214 9,054 1,076 6,840 1,838	60 1,000 100 36 90 7	1.20 20.0 2.00 0.72 1.80 0.14	E1 E2 E2 E1 E2 M

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ESWWS	477: NT/3b: Inland Scribbly Gum - Red Stringybark - Black Cypress Pine - Red Ironbark open forest on sandstone hills in the southern BBS and northern NSWSWS Bioregions	2,000 (1,400 - 2,600) ha 840 - 1,500 ha (42 - 75 %) 300 - 540 ha (12 - 39 %)	30-70% BBS 30-70% NSS	>70% Central West	Dapper NR**	1,101	80	4.00	M
					Yarrobil NP**	1,824	200	10.0	E4
					Goodiman SCA**	568	40	2.00	E4
					Durridgere SCA*	6,104	100	5.00	E4
ESWWS	479: NT/2a: Narrow-leaved Ironbark- Black Cypress Pine - stringybark +- Grey Gum +- Narrow-leaved Wattle shrubby open forest on sandstone hills in the southern BBS - Sydney Basin Bioregions	25,000 (18,000 - 32,000) ha 11,000 - 19,000 ha (44 - 76 %) 3,500 - 6,300 ha (11 - 35 %)	30-70% BBS <30% NSS 30-70% SB	<30% Hunter/Central R >70% Central West <30% Hawk/Nepean	Dapper NR**	1,101	450	1.80	E1
					Durridgere SCA*	6,104	2,200	8.80	E3
					Goulburn River NP*	73,445	2,050	8.20	E1
					Yarrobil NP**	1,824	200	0.80	E3
					Goodiman SCA**	568	10	0.04	E3
ESWWS	481: NT/2a: Rough-barked Apple - Blakely's Red Gum - Narrow-leaved Stringybark +/- Grey Gum sandstone riparian grass fern open forest on in the southern BBS and Upper Hunter regions	18,000 (13,000 - 23,000) ha 9,100 - 16,000 ha (51 - 89 %) 2,300 - 6,600 ha (10 - 51 %)	>70% SB <30% BBS	>70% Hunter/Central R	Manobalai NR*	3,799	6	0.03	M
					Goulburn River NP*	73,445	4,260	23.7	E1
					Durridgere SCA*	6,104	130	0.72	E3
					Wollemi NP*	500,843	10	0.06	E2
ESWWS	506: NT/2a: Black Cypress Pine - White Box - Tumbledown Gum shrubby open forest / woodland mainly in the Mt Kaputar region, Nandewar Bioregion	24,000 (17,000 - 31,000) ha 12,000 - 20,000 ha (50 - 83 %) 2,900 - 5,200 ha (9.4 - 31 %)	>70% NAN <30% BBS	30-70% Border R/Gwydir 30-70% Namoi	Horton Falls NP	260	46	0.19	E1
					Mount Kaputar NP	51,349	4,025	16.8	E3
ESWWS	517: E/5a: Grey Box shrubby open forest of northern parts of the Nandewar and New England Tablelands Bioregions	75,000 (38,000 - 110,000) ha 13,000 - 23,000 ha (17 - 31 %) 6 - 10 ha (0.0051 - 0.026 %)	30-70% NET 30-70% NAN	>70% Border R/Gwydir	Nullamanna NP	296	8	0.01	E3
ESWWS	530: LC/1b: Nandewar Box - Western New England Blackbutt - Red Stringybark open forest in the Kaputar area of the Nandewar Bioregion	10,000 (7,000 - 13,000) ha 5,600 - 10,000 ha (56 - 100 %) 4,400 - 8,100 ha (34 - 120 %)	>70% NAN	30-70% Border R/Gwydir 30-70% Namoi	Mount Kaputar NP	51,349	6,248	62.5	E1
ESWWS	542: NT/5a: Stringybark - Rough-barked Apple - cypress pine shrubby open forest of the eastern Nandewar and western New England Tablelands Bioregions	58,000 (41,000 - 75,000) ha 20,000 - 36,000 ha (34 - 62 %) 420 - 770 ha (0.56 - 1.9 %)	30-70% NAN 30-70% NET	30-70% Border R/Gwydir 30-70% Namoi	Gwydir River SCA	3,961	122	0.21	E3
					Warrabah NP	5,216	225	0.39	E3
					Watsons Creek NR	1,392	53	0.09	E3
					Linton NR	667	69	0.12	E3
					NCT Euroka COV	1,672	45	0.08	M
					NCT Rockview COV	1,925	52	0.09	E3
					VCA0167	390	29	0.05	E3
ESWWS	543: NT/4b: Rough-barked Apple - White Box - Rusty Fig shrubby open forest in the Kaputar area of Brigalow Belt South and Nandewar Bioregions	2,600 (1,900 - 3,300) ha 1,500 - 1,700 ha (58 - 65 %) 190 - 330 ha (5.8 - 17 %)	>70% NAN <30% BBS	30-70% Border R/Gwydir 30-70% Namoi	Mount Kaputar NP	51,349	260	10.0	E3

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ESWWS	549: NT/3a: Silver-leaved Ironbark - Black Cypress Pine -/+ White Box shrubby open forest mainly in the northern Nandewar Bioregion	26,000 (19,000 - 33,000) ha 11,000 - 19,000 ha (42 - 73 %) 1,100 - 1,800 ha (3.3 - 9.5 %)	>70% NAN <30% BBS	>70% Border R/Gwydir	Arakoola NR	3,164	750	2.88	E2
					Burral Yurrul NP	1,033	300	1.15	E2
					Burral Yurrul NR	1,341	300	1.15	E3
					Terry Hie Hie AA	15,324	80	0.31	E1
ESWWS	551: NT/4a: Orange Gum - Caleys Ironbark - stringybark - Tenterfield Woollybutt shrubby open forest of the Horton River area of the Nandewar Bioregion	10,000 (7,000 - 13,000) ha 4,200 - 7,800 ha (42 - 78 %) 110 - 190 ha (0.85 - 2.7 %)	>70% NAN	>70% Border R/Gwydir <30% Namoi	Horton Falls NP	260	149	1.49	M
ESWWS	552: NT/5b: Silvertop Stringybark - Rough-barked Apple - Eucalyptus quinniorum shrubby open forest of southern Nandewar and New England Tablelands Bioregions	8,200 (5,800 - 10,000) ha 5,300 - 9,700 ha (65 - 120 %) 96 - 170 ha (0.96 - 2.9 %)	<30% NAN >70% NET	<30% Border R/Gwydir >70% Namoi	Ironbark NR+	1,653	11	0.13	M
					Warrabah NP	5,216	45	0.55	E3
					NCT Rockview COV	1,925	48	0.59	E3
					VCA0100	704	32	0.39	M
ESWWS	555: NT/5b: White Cypress Pine - Orange Gum - Acacia granite outcrop shrubland in the Moonbi area of the Nandewar and New England Tablelands Bioregions	2,000 (1,400 - 2,600) ha 1,100 - 1,900 ha (55 - 95 %) 0 ha	>70% NAN <30% NET	>70% Namoi	Not Protected				
ESWWS	562: NT/3a: Tumbledown Red Gum - White Cypress Pine - Caley's Ironbark shrubby open forest of the Nandewar and western New England Tablelands Bioregions	52,000 (37,000 - 67,000) ha 24,000 - 42,000 ha (46 - 81 %) 2,600 - 4,700 ha (3.9 - 13 %)	30-70% NAN 30-70% NET	30-70% Border R/Gwydir 30-70% Namoi	Gwydir River NP	4,408	36	0.07	E3
					Gwydir River SCA	3,961	2,117	4.07	E3
					Warialda SCA	2,908	100	0.19	E2
					Warrabah NP	5,216	1,352	2.60	E3
					Bingara SCA	1,971	73	0.14	M
ESWWS	563: NT/5a: White Box - Silvertop Stringybark -/+ White Cypress Pine grass shrub open forest of the southern Nandewar, New England Tablelands Bioregions	116,000 (82,000 - 150,000) ha 45,000 - 83,000 ha (39 - 72 %) 110 - 180 ha (0.073 - 0.22 %)	>70% NAN <30% NET	<30% Border R/Gwydir <30% Hunter/Central R >70% Namoi	Mount Kaputar NP	51,349	130	0.11	E3
					Watsons Creek NR	1,392	4	<0.01	E3
					Wallabadah NR	1,134	11	0.01	E3
ESWWS	564: V/4a: White Cypress Pine - Silver-leaved Ironbark - Caley's Ironbark open forest of the central Nandewar and western New England Tablelands Bioregions	37,000 (26,000 - 48,000) ha 7,700 - 14,000 ha (21 - 38 %) 430 - 790 ha (0.9 - 3 %)	30-70% NAN 30-70% NET	>70% Border R/Gwydir <30% Namoi	Gwydir River NP	4,408	21	0.06	E3
					Bingara SCA	1,971	80	0.22	M
					NCT Bora Creek COV	481	63	0.17	E3
					NCT Euroka COV	1,672	448	1.21	M
ESWWS	573: NT/5b: Stringybark - spinifex woodland associated serpentinite outcrops in the Nandewar Bioregion	4,800 (3,400 - 6,200) ha 2,800 - 5,000 ha (58 - 100 %) 0 ha	>70% NAN <30% NET	30-70% Border R/Gwydir 30-70% Namoi	Not Protected				
ESWWS	576: NT/3b: Motherumbah - hill red gum - Black Cypress Pine shrubby low woodland mainly in the southern Nandewar Bioregion	1,300 (910 - 1,600) ha 840 - 1,500 ha (65 - 120 %) 230 - 410 ha (14 - 45 %)	>70% NAN <30% NET <30% BBS	30-70% Border R/Gwydir 30-70% Namoi	Mount Kaputar NP	51,349	302	23.2	E2
					Deriah AA	2,232	20	1.54	E3
ESWWS	577: V/4a: Tumbledown Red Gum - White Cypress Pine - Blakely's Red Gum shrubby forest of northern Nandewar Bioregion	50,000 (35,000 - 65,000) ha 14,000 - 26,000 ha (28 - 52 %) 430 - 790 ha (0.66 - 2.3 %)	>70% NAN <30% NET	>70% Border R/Gwydir	Kwiambal NP	9,726	611	1.22	E3

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ESWWS	578: NT/3a: Tumbledown Red Gum - Black Cypress Pine - Caley's Ironbark shrubby open forest of the Nandewar and western New England Tablelands Bioregions	28,900 (21,000 - 37,000) ha 14,000 - 24,000 ha (48 - 83 %) 2,300 - 4,100 ha (6.2 - 20 %)	<30% NAN >70% NET	>70% Border R/Gwydir <30% Namoi	Goonoowigal SCA+	1,053	200	0.69	E3
					Indwarra NP	933	90	0.31	E3
					Ironbark NR+	1,653	593	2.05	M
					Mount Yarrowyck NR	584	3	0.01	E3
					Nullamanna NP	296	200	0.69	E3
					The Basin NR	2,275	438	1.52	E3
					Warrabah NP	5,216	569	1.97	E3
					NCT Rockview COV	1,925	1,100	3.81	E3
ESWWS	579: LC/2a: Tumbledown Red Gum - Black Cypress Pine shrubby open forest on rhyolitc geology of the Nandewar and north west New England Tablelands Bioregions	17,000 (12,000 - 22,000) ha 8,400 - 15,000 ha (49 - 88 %) 1,800 - 3,300 ha (8.2 - 28 %)	<30% NAN >70% NET	>70% Border R/Gwydir	Severn River NR	5,847	2,567	15.1	M
ESWWS	580: NT/5b: Tumbledown Red Gum - Caley's Ironbark shrubby open forest on Rock of Gibraltar in the northern Nandewar Bioregion	1,200 (840 - 1,500) ha 560 - 1,000 ha (47 - 83 %) 0 ha	>70% NAN	>70% Border R/Gwydir	Not Protected				
ESWWS	581: NT/4b: Tumbledown Red Gum - Dwyer's Red Gum - Wallaby Bush shrubby woodland of the Nandewar Bioregion	1,600 (1,200 - 2,000) ha 560 - 1,000 ha (35 - 63 %) 140 - 250 ha (7 - 21 %)	>70% NAN	>70% Border R/Gwydir <30% Namoi	Somerton NP	757	132	8.25	E3
					Warialda NP	1,602	62	3.88	E3
ESWWS	587: LC/1a: White Box - White Cypress Pine - Rough-barked Apple shrubby open forest in the Kaputar area of Brigalow Belt South and Nandewar Bioregions	28,000 (20,000 - 36,000) ha 16,000 - 28,000 ha (57 - 100 %) 12,000 - 20,000 ha (33 - 100 %)	>70% NAN <30% BBS	<30% Border R/Gwydir >70% Namoi	Mount Kaputar NP	51,349	16,000	57.1	E2
					Leard SCA	1,175	25	0.09	E1
ESWWS	588: V/4a: White Box - White Cypress Pine shrubby hills open forest mainly in the Nandewar Bioregion	150,000 (110,000 - 190,000) ha 35,000 - 65,000 ha (23 - 43 %) 1,700 - 3,000 ha (0.89 - 2.7 %)	>70% NAN <30% NET <30% BBS	<30% Border R/Gwydir >70% Namoi	Gwydir River NP	4,408	397	0.26	E1
					Mount Kaputar NP	51,349	482	0.32	E2
					Somerton NP	757	116	0.08	E1
					Deriah AA	2,232	500	0.33	E2
					Leard SCA	1,175	840	0.56	E2
					VCA0091	2	2	<0.01	E1
ESWWS	591: NT/5a: White Box shrubby open forest on hills mainly in the Nandewar Bioregion	50,000 (35,000 - 65,000) ha 21,000 - 39,000 ha (42 - 78 %) 210 - 370 ha (0.32 - 1.1 %)	>70% NAN <30% NET <30% BBS	<30% Border R/Gwydir >70% Namoi	Melville Range NR	842	63	0.13	E3
					Mount Kaputar NP	51,349	222	0.44	E2
					VCA0103	11	3	0.01	E1
ESWWS	596: LC/3a: Tumbledown Red Gum - White Cypress Pine - Silver-leaved Ironbark shrubby woodland mainly in the northern Nandewar Bioregion	71,000 (50,000 - 92,000) ha 31,000 - 57,000 ha (44 - 80 %) 3,700 - 6,700 ha (4 - 13 %)	>70% NAN <30% BBS	>70% Border R/Gwydir	Kwiambal NP	9,726	49	0.07	E3
					Kwiambal NP	9,726	5,105	7.19	E3
					Burral Yurrul NP	1,033	60	0.08	E3
					Burral Yurrul NR	1,341	5	0.01	E4

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ESWWS	598: V/3a: Silver-leaved Ironbark - White Box - White Cypress Pine viney scrub woodland in the Nandewar and BBS Bioregions	14,000 (9,800 - 18,000) ha 3,500 - 6,500 ha (25 - 46 %) 990 - 1,800 ha (5.5 - 18 %)	>70% NAN <30% BBS	>70% Border R/Gwydir <30% Namoi	Bingara SCA	1,971	440	3.14	E2
					Gwydir River NP	4,408	4	0.03	E3
					Kelvin AA	2,263	11	0.08	E3
					Somerton NP	757	151	1.08	E3
					Warialda NP	1,602	76	0.54	E3
					Warialda SCA	2,908	50	0.36	E3
					Bullala NP	5,869	620	4.43	E2
					NCT Bora Creek COV	481	58	0.41	E3
ESWWS	632: E/5b: Narrow-leaved Black Peppermint open forest mainly on acid volcanics in the western New England Bioregion	2,000 (1,000 - 3,000) ha 200 - 600 ha (10 - 30 %) 3 - 17 ha (0.1 - 1.7 %)	>70% NET	>70% Border R/Gwydir	Single NP	2,566	10	0.50	E4
EWLFSC	621: NT/4b: Grey Gum - Rough-barked Apple alluvial flat woodland in the upper Hunter Valley, mainly Sydney Basin Bioregion	2,000 (1,000 - 3,000) ha 500 - 1,500 ha (25 - 75 %) 91 - 510 ha (3 - 51 %)	>70% SB <30% BBS	>70% Hunter/Central R	Towarri NP*	6,517	203	10.2	M
					Wingen Maid NR*	1,093	100	5.00	E3
EWLFSC	624: LC/3b: Large-fruited Grey Gum - Narrow-leaved Stringybark open forest on sheltered sandstone hillslopes in the Scone region of the upper Hunter Valley	4,000 (2,800 - 5,200) ha 2,500 - 4,500 ha (63 - 110 %) 710 - 700 ha (14 - 25 %)	<30% BBS >70% SB	>70% Hunter/Central R	Towarri NP*	6,517	208	5.20	M
					Wingen Maid NR*	1,093	500	12.5	E3
EWLFST	502: LC/4a: Black Cypress Pine - Orange Gum - Tumbledown Red Gum shrubby woodland on granites of the Nandewar and New England Tablelands Bioregions	85,000 (60,000 - 110,000) ha 24,000 - 44,000 ha (28 - 52 %) 2,100 - 3,800 ha (1.9 - 6.3 %)	30-70% NET 30-70% NAN	>70% Namoi <30% Border R/Gwydir	Indwarra NP	933	31	0.04	E3
					Ironbark NR+	1,653	40	0.05	M
					Mount Yarrowyck NR	584	3	<0.01	E3
					Stony Batter Creek NR+	563	63	0.07	E3
					The Basin NR	2,275	84	0.10	E3
					Warrabah NP	5,216	1,392	1.64	E3
					VCA0100	704	45	0.05	M
					VCA0083	209	45	0.05	E3
					NCT Rockview COV	1,925	1,260	1.48	E3
EWLFST	503: LC/4a: Black Cypress Pine - Orange Gum heath shrubland or woodland on granite outcrops of the New England Tablelands Bioregion	38,200 (27,000 - 49,000) ha 16,000 - 29,000 ha (42 - 76 %) 820 - 1,500 ha (1.7 - 5.6 %)	<30% NAN >70% NET	30-70% Border R/Gwydir 30-70% Namoi	Ironbark NR+	1,653	291	0.76	M
					Linton NR	667	12	0.03	E3
					Single NP	2,566	28	0.07	M
					Warrabah NP	5,216	253	0.66	E3
					VCA0100	704	140	0.37	M
					NCT Rockview COV	1,925	445	1.16	E3
EWLFST	504: NT/4a: Black Cypress Pine - Rough-barked Apple - stringybark shrubby open forest of the Nandewar and western New England Tablelands Bioregions	39,000 (28,000 - 50,000) ha 14,000 - 25,000 ha (36 - 64 %) 460 - 840 ha (0.92 - 3 %)	30-70% NET 30-70% NAN	>70% Border R/Gwydir <30% Namoi	Goonoowigal SCA+	1,053	649	1.66	E3

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EWLFST	505: NT/4a: Black Cypress Pine - Tumbledown Red Gum - Narrow-leaved Ironbark - Stringybark She Oak open forest on acid volcanics of the western New England Tablelands Bioregion	93,600 (66,000 - 120,000) ha 23,000 - 41,000 ha (25 - 44 %) 940 - 1,700 ha (0.78 - 2.6 %)	<30% NAN >70% NET	>70% Border R/Gwydir	Kings Plains NP Severn River NR	8,228 5,847	633 696	0.68 0.74	M M
EWLFST	512: NT/4a: Caley's Ironbark - Orange Gum - Black Cypress Pine shrubby open forest on acid volcanics of the northern New England Tablelands Bioregion	85,900 (43,000 - 120,000) ha 16,000 - 46,000 ha (19 - 54 %) 530 - 980 ha (0.44 - 2.3 %)	<30% NAN >70% NET	>70% Border R/Gwydir	Fladbury SCA Kings Plains NP Single NP	114 8,228 2,566	68 681 6	0.08 0.79 0.01	E3 M M
EWLFST	514: NT/4b: Black Cypress Pine - Rough-barked Apple - Round-leaved Gum shrubby riparian forest in the Torrington area of the New England Tablelands Bioregion	2,000 (1,400 - 2,600) ha 1,600 - 1,800 ha (80 - 90 %) 150 - 270 ha (5.8 - 19 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA	30,430	214	10.7	M
EWLFST	523: V/4a: McKie's Stringybark - Western New England Blackbutt - Rough-barked Apple open forest of the New England Tablelands Bioregion	30,000 (21,000 - 39,000) ha 11,000 - 19,000 ha (37 - 63 %) 660 - 1,200 ha (1.7 - 5.7 %)	<30% NAN >70% NET	>70% Border R/Gwydir <30% Namoi	Fladbury SCA Kings Plains NP Single NP Stonewoman AA+	114 8,228 2,566 2	45 28 865 2	0.15 0.09 2.88 0.01	E3 M M E3
EWLFST	536: LC/1a: Orange Gum - Black Cypress Pine shrubby open forest on acid volcanics of the north western New England Tablelands Bioregion	15,000 (11,000 - 19,000) ha 7,000 - 13,000 ha (47 - 87 %) 4,900 - 5,800 ha (26 - 53 %)	<30% NAN >70% NET	>70% Border R/Gwydir	Kings Plains NP Severn River NR	8,228 5,847	4,900 450	32.7 3.00	M M
EWLFST	537: NT/4a: Orange Gum - Caley's Ironbark - Red Stringybark open forest of the southern Nandewar and New England Tablelands Bioregions	100,000 (50,000 - 150,000) ha 18,000 - 52,000 ha (18 - 52 %) 1,100 - 1,900 ha (0.73 - 3.8 %)	<30% NAN >70% NET	<30% Border R/Gwydir >70% Namoi	Indwarra NP Single NP Stony Batter Creek NR+ The Basin NR Watsons Creek NR Watsons Creek SCA NCT Rockview COV	933 2,566 563 2,275 1,392 520 1,925	18 6 135 1,274 62 2 1	0.02 0.01 0.14 1.27 0.06 <0.01 <0.01	E3 M E3 E3 E3 E3 E3
EWLFST	550: NT/1b: Silvertop Stringybark - Nandewar Box shrubby open forest in the Kaputar area of the Nandewar Bioregion	6,000 (5,400 - 6,600) ha 4,900 - 5,900 ha (82 - 98 %) 3,900 - 7,100 ha (59 - 130 %)	>70% NAN	30-70% Border R/Gwydir 30-70% Namoi	Mount Kaputar NP	51,349	5,500	91.7	E2
EWLFST	556: NT/5b: Orange Gum - Caley's Ironbark - stringybark shrubby open forest of the northern New England Tablelands Bioregion	8,000 (5,600 - 10,000) ha 3,600 - 6,600 ha (45 - 83 %) 54 - 98 ha (0.54 - 1.8 %)	>70% NET	>70% Border R/Gwydir	Bolivia Hill NR Currys Gap SCA+ VCA0028	1,789 220 50	40 25 11	0.50 0.31 0.14	E1 E2 E3
EWLFST	557: LC/1a: Western New England Blackbutt - Round-leaved Gum - Stringybark shrubby open forest in the Torrington area of the New England Tablelands Bioregion	31,000 (22,000 - 40,000) ha 19,000 - 33,000 ha (61 - 110 %) 9,200 - 17,000 ha (23 - 77 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA	30,430	13,100	42.3	E1

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EWLFST	558: NT/2a: Western New England Blackbutt - stringybark open forest of the Nandewar and New England Tablelands Bioregions	36,000 (26,000 - 46,000) ha 13.000 - 23,000 ha (36 - 64 %) 4,100 - 7,400 ha (8.9 - 28 %)	<30% NAN >70% NET	30-70% Border R/Gwydir 30-70% Namoi <30% Northern Rivers	Bluff River NR	1,762	209	0.58	M
					Bolivia Hill NR	1,789	763	2.12	M
					Donnybrook NR	277	1	<0.01	E3
					Indwarra NP	933	550	1.53	E3
					Linton NR	667	170	0.47	E3
					Mount Yarrowyck NR	584	24	0.07	E3
					Single NP	2,566	1,570	4.36	M
					Stony Batter Creek NR+	563	303	0.84	E3
					The Basin NR	2,275	374	1.04	E3
					Watsons Creek NR	1,392	1,170	3.25	E3
					Watsons Creek SCA	520	514	1.43	E3
					VCA0083	209	80	0.22	E3
EWLFST	559: E/5a: Youman's Stringybark - Mountain Gum open forest of the western New England Tablelands Bioregion	50,000 (25,000 - 75,000) ha 5,000 - 15,000 ha (10 - 30 %) 180 - 330 ha (0.24 - 1.3 %)	<30% NAN >70% NET	30-70% Border R/Gwydir 30-70% Namoi <30% Northern Rivers	Aberbaldie NR	285	187	0.37	M
					Watsons Creek NR	1,392	28	0.06	E3
					VCA0083	209	40	0.08	E3
EWLFST	568: V/4a: Broad-leaved Stringybark shrub/grass open forest of the New England Tablelands Bioregion	17,000 (12,000 - 22,000) ha 4,900 - 9,100 ha (29 - 54 %) 320 - 590 ha (1.5 - 4.9 %)	<30% NAN >70% NET	30-70% Border R/Gwydir <30% Namoi 30-70% Northern Rivers	Aberbaldie NR	285	42	0.25	M
					Avondale SCA	314	6	0.04	E3
					Booroolong NR	967	242	1.42	M
					Donnybrook NR	277	70	0.41	E3
					Duval NR	243	14	0.08	M
					Imbota NR	218	40	0.24	E1
					Yina NR	98	40	0.24	E1
EWLFST	575: NT/3b: Tenterfield Woollybutt - Silvertop Stringybark open forest of the New England Tablelands	4,500 (3,200 - 5,800) ha 1,900 - 3,500 ha (42 - 78 %) 530 - 970 ha (9.1 - 30 %)	>70% NET	>70% Border R/Gwydir <30% Northern Rivers	Bluff River NR	1,762	500	11.1	M
					Bolivia Hill NR	1,789	187	4.16	M
					Booroolong NR	967	18	0.40	M
					Currys Gap SCA+	220	30	0.67	E2
					VCA0028	50	15	0.33	E3
EWLFST	583: V/5c: Wallangara White Gum - Orange Gum open woodland on granite outcrops in the far northern New England Tablelands Bioregion	230 (120 - 340) ha 100 - 300 ha (43 - 130 %) 0 ha	>70% NET	>70% Border R/Gwydir	Not Protected				
EWLFST	584: V/4b: Western New England Blackbutt - Narrow-leaved Ironbark - Stringybark She Oak open forest of the western New England Tablelands Bioregion	2,000 (1,000 - 3,000) ha 400 - 1,200 ha (20 - 60 %) 110 - 190 ha (3.7 - 19 %)	>70% NET	>70% Border R/Gwydir	Severn River NR	5,847	152	7.60	E1
EWLFST	585: LC/1a: Western New England Blackbutt - Orange Gum - Black Cypress Pine shrubby woodland in the Torrington area of the New England Tablelands Bioregion	23,000 (17,000 - 29,000) ha 15,000 - 27,000 ha (65 - 120 %) 7,300 - 13,000 ha (25 - 76 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA	30,430	10,334	44.9	E1

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EWLFST	605: V/5c: Orange Gum Swamp Woodland on acid volcanic-derived sediments in the western New England Tablelands bioregion	50 (25 - 75) ha 20 - 60 ha (40 - 120 %) 4 - 7 ha (4.7 - 26 %)	>70% NET	>70% Border R/Gwydir	Single NP	2,566	5	10.0	E1
EWLFST	609: NT/2b: Black Cypress Pine - Caley's Ironbark - Tumbledown Red Gum shrubby woodland on Mole Granite of the Torrington area of the New England Tablelands Bioregion	11,000 (7,700 - 14,000) ha 8,100 - 9,900 ha (74 - 90 %) 3,200 - 5,800 ha (23 - 75 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA	30,430	4,486	40.8	M
EWLFST	626: NT/5c: Murrurundi Stringybark dry open forest on conglomerate outcrops in the upper Hunter Valley region	300 (210 - 390) ha 180 - 320 ha (60 - 110 %) 7 - 13 ha (1.8 - 6.2 %)	30-70% NNC 30-70% NET	>70% Hunter/Central R	Murrurundi Pass NP*	215	10	3.33	M
EWRHI	424: LC/3c: Dwyers Red Gum heathy low open woodland on sandstone ridges in the Pilliga Scrub, BBS Bioregion	400 (280 - 520) ha 280 - 520 ha (70 - 130 %) 110 - 190 ha (21 - 68 %)	>70% BBS	>70% Namoi	Pilliga NR Pilliga East SCA	85,354 24,575	100 50	25.0 12.5	E3 E4
EWT	071: E/4a: Carbeen - White Cypress Pine - River Red Gum - bloodwood tall woodland on sandy loam alluvial and eolian soils in the northern BBS and DRP Bioregions	20,000 (18,000 - 22,000) ha 4,100 - 4,900 ha (21 - 25 %) 210 - 240 ha (0.95 - 1.3 %)	<30% BBS >70% DRP <30% NAN	>70% Border R/Gwydir <30% Namoi <30% Western	Boomi NR# Boomi West NR# Boronga NR# Dthinna Dthinnawan NP	158 149 198 27,819	35 30 62 100	0.18 0.15 0.31 0.50	E1 M E1 E3
FWI	053: V/4a: Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluivial plains and floodplains	150,000 (75,000 - 220,000) ha 25,000 - 75,000 ha (17 - 50 %) 1,800 - 3,200 ha (0.82 - 4.3 %)	<30% BBS 30-70% DRP <30% MUL <30% RIV <30% NSS	30-70% Border R/Gwydir 30-70% Central West <30% Lachlan <30% Murray <30% Murrumbidgee <30% Namoi <30% Western	Boomi NR# Budelah NR# Kirramingly NR Macquarie Marshes NR# Nocoleche NR+ Boomi West NR# Boronga NR# Bullala NP	158 4,055 1,331 21,920 71,162 149 198 5,869	2 17 9 2,000 500 5 3 2	<0.01 0.01 0.01 1.33 0.33 <0.01 <0.01 <0.01	E1 E2 M E2 E2 E1 E1 M
FWI	238: NT/5a: Permanent and semi-permanent freshwater lakes wetland of the inland slopes and plains	1,000,000 (500,000 - 1,500,000) ha 200,000 - 600,000 ha (20 - 60 %) 710 - 2,100 ha (0.047 - 0.42 %)	<30% BBS >70% DRP <30% MUL <30% MDD <30% NSS 30-70% RIV <30% SSD	<30% Border R/Gwydir <30% Central West <30% Lachlan <30% Lower MD <30% Murray <30% Murrumbidgee <30% Namoi <30% Western	Billabong FR+ Macquarie Marshes NR# Moira Lakes FR+ Morrisons Lake NR+ Peacock Creek FR+ Pollack FR+ Willandra NP+ Yanga NP+	1,034 21,920 1,441 319 110 714 18,851 8,638	19 300 664 180 5 6 100 130	<0.01 0.03 0.07 0.02 <0.01 <0.01 0.01 0.01	E1 E3 E1 E2 E2 E1 E4 E2
FWI	241: NT/5b: River Cooba swamp wetland on the floodplains of the Darling Riverine Plains and BBS Bioregions	10,000 (7,000 - 13,000) ha 3,500 - 6,500 ha (35 - 65 %) 77 - 140 ha (0.59 - 2 %)	<30% BBS 30-70% DRP	30-70% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Macquarie Marshes NR# Narran Lake NR# Toorale NP# + Gwydir Wetlands SCA# +	21,920 28,397 91,527 4,292	10 30 50 20	0.10 0.30 0.50 0.20	E2 E3 E4 E2

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FWI	247: E/4a: Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South and Darling Riverine Plains Bioregions	350,000 (250,000 - 450,000) ha 91,000 - 160,000 ha (26 - 46 %) 3,500 - 6,400 ha (0.78 - 2.6 %)	<30% BBS >70% DRP	<30% Border R/Gwydir <30% Central West <30% Namoi 30-70% Western	Culgoa NP# + Gundabooka NP+ Macquarie Marshes NR# Narran Lake NR# Budelah NR# Gwydir Wetlands SCA# +	36,520 64,134 21,920 28,397 4,055 4,292	21 300 50 4,550 40 26	0.01 0.09 0.01 1.30 0.01 0.01	M E3 E1 E1 E1 E2
FWI	361: V/3c: Sedgeland fen wetland of spring-fed or runoff-fed creeks in the southern Pilliga - Warrumbungle Range region, BBS Bioregion	200 (140 - 260) ha 70 - 130 ha (35 - 65 %) 30 - 90 ha (12 - 64 %)	30-70% BBS	30-70% Central West 30-70% Namoi	Pilliga NR	85,354	60	30.0	E1
FWI	364: NT/5b: Wetland on sodic soils in the Yetman-Yelarbon region, mainly BBS Bioregion	500 (350 - 650) ha 210 - 390 ha (42 - 78 %) 2 - 5 ha (0.23 - 1.3 %)	>70% BBS <30% DRP	>70% Border R/Gwydir	Dthinna Dthinnawan NR#	2,009	3	0.60	E4
FWI	375: V/5c: Budda Pea - Channel Millet ephemeral reedland wetland on floodplains in north-western NSW	400 (280 - 520) ha 90 - 110 ha (23 - 28 %) 6 - 34 ha (1.2 - 12 %)	<30% BBS 30-70% DRP	<30% Border R/Gwydir >70% Western	Narran Lake NR#	28,397	20	5.00	E3
FWI	400: V/4c: Riparian sedgeland rushland wetland of the Pilliga to Goonoo sandstone forests, BBS Bioregion	80 (56 - 100) ha 46 - 84 ha (58 - 110 %) 5 - 27 ha (4.8 - 48 %)	>70% BBS	>70% Namoi <30% Central West	Pilliga West SCA# Pilliga West NP Pilliga SCA Timallallie NP Breelong NP	36,241 8,005 33,289 39,277 6,840	5 2 2 2 5	6.25 2.50 2.50 2.50 6.25	E4 E4 E4 E4 E2
FWI	410: V/2e: Swamp Paper-bark very tall shrubland wetland on sodic soils in the Pilliga Scrub region	1,300 (910 - 1,600) ha 900 - 1,100 ha (69 - 85 %) 640 - 780 ha (40 - 86 %)	>70% BBS	>70% Namoi	Pilliga NP Pilliga SCA	10,606 33,289	700 10	53.8 0.77	M E3
FWI	416: E/3c: Pilliga "tank gilgai" wetland sedgeland rushland, BBS Bioregion	150 (110 - 190) ha 49 - 91 ha (33 - 61 %) 32 - 94 ha (17 - 85 %)	>70% BBS <30% DRP	>70% Namoi	Pilliga NP Pilliga SCA	10,606 33,289	50 13	33.3 8.67	E3 E3
FWI	447: E/5b: Sedgeland - forbland wetland in depressions on valley flats of the NSW North-western Slopes	500 (150 - 850) ha 45 - 250 ha (9 - 50 %) 7 - 13 ha (0.82 - 8.7 %)	<30% NAN 30-70% BBS	30-70% Border R/Gwydir <30% Namoi	Arakoola NR	3,164	10	2.00	E1
FWI	465: E/5c: Reedland - tussock grass - segeland fen swampy wetland of impeded creeks in southern BBS Bioregion	100 (50 - 150) ha 10 - 30 ha (10 - 30 %) 0 ha	>70% BBS	>70% Central West	Not Protected				
FWMAL	500: CE/5b: Upland wetlands of the New England Tablelands Bioregion	6,600 (3,300 - 9,900) ha 1,400 - 2,600 ha (21 - 39 %) 290 - 350 ha (2.9 - 11 %)	>70% NET	30-70% Border R/Gwydir 30-70% Northern Rivers <30% Namoi	Little Llangothlin NR Mother Of Ducks Lag. NR+ Single NP VCA0061	255 188 2,566 43	114 178 1 28	1.73 2.70 0.02 0.42	M M E4 M

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FWMB	497: NT/2e: Tea tree shrubland / sedgeland / forbland swamp wetland on the Liverpool Range, mainly BBS Bioregion	350 (320 - 380) ha 270 - 330 ha (77 - 94 %) 190 - 350 ha (50 - 110 %)	>70% BBS <30% NET	30-70% Hunter/Central R 30-70% Namoi	Murrurundi Pass NP* Coolah Tops NP	215 16,220	1 270	0.29 77.1	M E1
FWMB	607: CE/4e: Montane bogs on the western fall of the New England Tablelands Bioregion	300 (150 - 450) ha 100 - 300 ha (33 - 100 %) 29 - 87 ha (6.4 - 58 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA Bolivia Hill NR	30,430 1,789	50 8	16.7 2.67	E1 M
FWSS	582: E/5b: Sedgeland fens wetland of impeded drainage of the Nandewar and New England Tablelands Bioregions	10,000 (5,000 - 15,000) ha 4,200 - 7,800 ha (42 - 78 %) 50 - 92 ha (0.33 - 1.8 %)	<30% NAN >70% NET	30-70% Border R/Gwydir <30% Hunter/Central R <30% Namoi 30-70% Northern Rivers	Gwydir River SCA Ironbark NR+ Little Llangothlin NR Mummel Gulf NP Werrikimbe NP VCA0061 NCT Euroka COV	3,961 1,653 255 14,045 35,044 43 1,672	1 1 8 7 50 1 3	0.01 0.01 0.08 0.07 0.50 0.01 0.03	E3 E3 E3 E3 E3 E3 M
GFAPF	050: LC/5a: Couch Grass grassland wetland on river banks and floodplains of inland river systems	50,000 (25,000 - 75,000) ha 15,000 - 45,000 ha (30 - 90 %) 45 - 55 ha (0.06 - 0.22 %)	<30% BBS 30-70% DRP <30% MUL <30% RIV	30-70% Border R/Gwydir <30% Central West <30% Lachlan <30% Lower MD <30% Murray <30% Murrumbidgee <30% Namoi <30% Western	Moira Lakes FR+	1,441	50	0.10	E4
GFAPF	204: E/4a: Water Couch marsh grassland wetland of frequently flooded inland watercourses	90,000 (63,000 - 110,000) ha 11,000 - 19,000 ha (12 - 21 %) 1,800 - 2,100 ha (1.6 - 3.3 %)	<30% BBS >70% DRP	30-70% Border R/Gwydir <30% Central West <30% Namoi	Macquarie Marshes NR# Gwydir Wetlands SCA# +	21,920 4,292	940 1,040	1.04 1.16	E3 M
GFTI	043: V/4a: Mitchell Grass grassland - chenopod low open shrubland on floodplains in the semi-arid (hot) and arid zones	350,000 (180,000 - 520,000) ha 110,000 - 190,000 ha (31 - 54 %) 4,200 - 7,600 ha (0.81 - 4.2 %)	>70% DRP <30% MUL <30% BBS	<30% Border R/Gwydir <30% Central West <30% Namoi 30-70% Western	Culgoa NP# + Narran Lake NR# Paroo-Darling NP# +	36,520 28,397 176,413	4,000 1,760 120	1.14 0.50 0.03	E1 E1 M
GFTI	049: NT/3a: Partly derived Windmill Grass - copperburr alluvial plains shrubby grassland of the Darling Riverine Plains and BBS Bioregions	60,000 (30,000 - 90,000) ha 15,000 - 45,000 ha (25 - 75 %) 3,600 - 6,600 ha (4 - 22 %)	<30% BBS >70% DRP	>70% Border R/Gwydir <30% Central West <30% Namoi	Arakoola NR Careunga NR Macquarie Marshes NR# Midkin NR# Gwydir Wetlands SCA# +	3,164 493 21,920 374 4,292	524 20 4,000 40 500	0.87 0.03 6.67 0.07 0.83	E1 E3 E2 E2 E2
GFTI	052: E/5a: Queensland Bluegrass -/+ Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plain Bioregion	300,000 (150,000 - 450,000) ha 45,000 - 130,000 ha (15 - 43 %) 2,200 - 2,600 ha (0.49 - 1.7 %)	<30% BBS >70% DRP	>70% Border R/Gwydir <30% Namoi <30% Western	Budelah NR# Kirramingly NR Boomi West NR# Careunga NR Bullala NP	4,055 1,331 149 493 5,869	1,200 1,100 10 23 48	0.40 0.37 <0.01 0.01 0.02	E2 M E2 M M

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GFTI	102: CE/5a: Liverpool Plains grassland mainly on basaltic black earth soils, BBS Bioregion	280,000 (260,000 - 300,000) ha 7,200 - 8,800 ha (2.6 - 3.1 %) 0 ha	>70% BBS <30% NAN	<30% Border R/Gwydir >70% Namoi	Not Protected				
GFTI	395: LC/1a: Derived speargrass - wallaby grass - wire grass mixed forb grassland mainly in the Coonabarabran - Pilliga - Coolah region	100 (90 - 110) ha 5,000 - 15,000 ha (5000 - 15000 %) 520 - 940 ha (470 - 1040 %)	>70% BBS	30-70% Namoi 30-70% Central West	Warrumbungle NP	23,595	730	730.0	E2
GFTI	427: NT/2c: Cypress pine - Tumbledown Red Gum low open woodland to grassland on rocky benches, mainly in the Nandewar Bioregion	300 (210 - 390) ha 260 - 300 ha (87 - 100 %) 72 - 210 ha (18 - 100 %)	>70% NAN <30% BBS	>70% Namoi <30% Border R/Gwydir	Deriah AA Mount Kaputar NP Leard SCA Terry Hie Hie AA	2,232 51,349 1,175 15,324	26 50 50 17	8.67 16.7 16.7 5.67	M E3 E2 M
GFTI	451: LC/3a: Spear Grass - Slender Bamboo Grass mixed tussock derived grassland mainly of the northern BBS and Nandewar Bioregions	500 (350 - 650) ha 3,000 - 17,000 ha (600 - 3400 %) 25 - 130 ha (3.8 - 37 %)	30-70% BBS 30-70% NAN <30% NET	30-70% Border R/Gwydir <30% Namoi	Bullala NP	5,869	82	16.4	M
GFTI	484: LC/5a: Derived tall spear grass grassland on mainly basalt hills of the Liverpool Plains. Liverpool Range and in the upper Hunter Valley (Merriwa district), south-eastern BBS Bioregion	100 (70 - 130) ha 56,000 - 100,000 ha (56000 - 100000 %) 26 - 490 ha (20 - 700 %)	>70% BBS	30-70% Hunter/Central R 30-70% Namoi <30% Central West	Coolah Tops NP	16,220	260	260.0	E3
GFTI	511: LC/1c: Queensland Bluegrass - Redleg Grass - Rats Tail Grass - spear grass - panic grass derived grassland of the Nandewar and BBS Bioregions	1,000 (500 - 1,500) ha 100,000 - 300,000 ha (10000 - 30000 %) 510 - 920 ha (34 - 180 %)	>70% NAN <30% BBS	30-70% Namoi 30-70% Border R/Gwydir	Leard SCA Burral Yurrul NR Planchonella NR Terry Hie Hie AA Bingara SCA Yarrobil NP** Dowe NP	1,175 1,341 723 15,324 1,971 1,824 380	5 8 100 530 47 15 10	0.50 0.80 10.0 53.0 4.70 1.50 1.00	M E3 E1 E1 M E3 E1
GFTI	619: LC/4a: Derived Wire Grass grassland of the NSW Brigalow Belt South and Nandewar Bioregions	200 (100 - 300) ha 75,000 - 220,000 ha (37500 - 110000 %) 0 ha	30-70% BBS 30-70% NAN	30-70% Border R/Gwydir <30% Central West 30-70% Namoi	Not Protected				
GTM	569: LC/5a: Derived Snow Grass -+ Kangaroo Grass -+ Wild Sorghum tussock grassland of the NSW Northern Tablelands	500 (350 - 650) ha 100,000 - 300,000 ha (20000 - 60000 %) 380 - 700 ha (58 - 200 %)	>70% NET <30% NAN <30% BBS	30-70% Border R/Gwydir 30-70% Northern Rivers	Coolah Tops NP Towarri NP*	16,220 6,517	80 460	16.0 92.0	E1 E1
GTM	586: E/5b: Snow Grass - Swamp Foxtail tussock grassland sedgeland of cold air drainage valleys of the New England Tablelands Bioregion	4,000 (400 - 7,600) ha 100 - 1,900 ha (2.5 - 48 %) 2 - 5 ha (0.02 - 1.1 %)	>70% NET	30-70% Border R/Gwydir 30-70% Northern Rivers <30% Namoi	Yina NR	98	3	0.08	E1

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HGW	117: LC/3a: Buck Spinifex shrubby hummock grassland / Coolabah Apple - Silver-leaved Ironbark open woodland on deep sand in the Enngonia to Cumborah regions, north western NSW	60,000 (54,000 - 66,000) ha 52,000 - 62,000 ha (87 - 100 %) 5,800 - 7,000 ha (8.8 - 13 %)	<30% DRP 30-70% MUL 30-70% BBS	>70% Western	Ledknapper NR+ Narran Lake NR#	48,087 28,397	5,324 1,110	8.87 1.85	M M
HGW	235: NT/2b: Yelarbon Buloke - Western Grey Box - spinifex low open woodland / hummock grassland on sandy sodic soils	3,000 (2,700 - 3,300) ha 1,800 - 2,200 ha (60 - 73 %) 400 - 1,200 ha (12 - 44 %)	30-70% BBS 30-70% DRP	>70% Border R/Gwydir	Dthinna Dthinnawan NP	27,819	800	26.7	E1
HGW	460: NT/4e: Tumbledown Gum - ironbark - Porcupine Grass hummock grassland / low woodland of the Mount Kaputar to Bingara region, Nandewar Bioregion	150 (110 - 190) ha 98 - 180 ha (65 - 120 %) 28 - 52 ha (15 - 47 %)	>70% NAN	<30% Namoi 30-70% Border R/Gwydir	Mount Kaputar NP Bingara SCA	51,349 1,971	20 20	13.3 13.3	E3 M
HSOT	366: LC/2e: Fringe Myrtle heathland / shrubland on rock platforms in BBS Bioregion	170 (160 - 180) ha 140 - 160 ha (82 - 94 %) 120 - 130 ha (67 - 81 %)	>70% BBS	>70% Border R/Gwydir	Dthinna Dthinnawan NP Dthinna Dthinnawan NR#	27,819 2,009	119 4	70.0 2.35	M M
HSOT	391: LC/1b: Warrumbungle trachyte outcrop heathland / low woodland	1,700 (1,200 - 2,200) ha 1,200 - 2,000 ha (71 - 120 %) 1,300 - 1,500 ha (59 - 130 %)	>70% BBS	30-70% Namoi	Warrumbungle NP	23,595	1,400	82.4	E1
HSOT	392: V/1e: Warrumbungle She Oak heathland	20 (18 - 22) ha 18 - 22 ha (90 - 110 %) 20 - 20 ha (91 - 110 %)	>70% BBS	>70% Namoi	Warrumbungle NP	23,595	20	100	E3
HSOT	415: LC/3c: Fringe Myrtle shrubland of the Pilliga Scrub	150 (110 - 190) ha 98 - 180 ha (65 - 120 %) 25 - 75 ha (13 - 68 %)	>70% BBS	>70% Namoi	Pilliga SCA	33.289	50	33.3	E3
HSOT	425: NT/2e: Spur-wing Wattle heath on sandstone substrates in the Goonoo - Pilliga forests, BBS Bioregion	30 (21 - 39) ha 19 - 35 ha (63 - 120 %) 12 - 20 ha (31 - 95 %)	>70% BBS	30-70% Namoi 30-70% Central West	Timallallie NP Goonoo NP Biddon SCA	39,277 9,054 3,349	5 5 6	16.7 16.7 20.0	E3 E3 E3
HSOT	472: CE/5c: Thyme Honey-myrtle - red gum - Mugga Ironbark shrubland / woodland in impeded drainage flats or depressions in the southern BBS Bioregion	500 (250 - 750) ha 75 - 220 ha (15 - 44 %) 1 - 3 ha (0.08 - 1.4 %)	>70% BBS	>70% Central West	Dapper NR**	1,101	2	0.40	E4
HSOT	499: LC/3e: Tree Violet - cough bush basalt scree slopes shrubland of the Liverpool Range - Wollemi region, BBS and Sydney Basin Bioregions	50 (25 - 75) ha 23 - 67 ha (46 - 130 %) 8 - 22 ha (10 - 88 %)	30-70% BBS 30-70% SB	30-70% Hunter/Central R 30-70% Namoi <30% Central West	Coolah Tops NP Wollemi NP* Towarri NP*	16,220 500,843 6,517	5 5 5	10.0 10.0 10.0	E3 E3 E3

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HSOT	519: E/5b: Heathy shrubland on granitic substrates in the Howell area in the New England Tablelands Bioregion	4,000 (2,000 - 6,000) ha 1,900 - 5,500 ha (48 - 140 %) 94 - 170 ha (1.6 - 8.5 %)	>70% NET <30% NAN	>70% Border R/Gwydir	Goonoowigal SCA+ Gwydir River SCA Warrabah NP NCT Euroka COV	1,053 3,961 5,216 1,672	67 11 2 54	1.68 0.28 0.05 1.35	E3 E3 E3 M
HSOT	520: NT/5b: Heathy outcrop shrublands on volcanic sediments of the Nandewar and BBS Bioregions	1,400 (980 - 1,800) ha 910 - 1,600 ha (65 - 110 %) 20 - 36 ha (1.1 - 3.7 %)	>70% NAN <30% BBS	>70% Namoi	Kelvin AA Mount Kaputar NP	2,263 51,349	5 23	0.36 1.64	E3 E3
HSOT	521: LC/1b: Mount Kaputar Kunzea - Five Star Heath - Spur-wing Wattle shrubland on siliceous outcrops mainly in the Nandewar Bioregion	1,500 (1,100 - 1,900) ha 1,400 - 1,600 ha (93 - 110 %) 1,300 - 1,500 ha (68 - 140 %)	>70% NAN <30% BBS	<30% Border R/Gwydir >70% Namoi	Mount Kaputar NP Deriah AA	51,349 2,232	1,370 15	91.3 1.00	E3 M
HSOT	535: LC/2b: Orange Gum - Black Cypress Pine heathy woodland on outcropping granite in the Torrington area of the New England Tablelands Bioregion	3,500 (1,800 - 5,200) ha 2,400 - 4,400 ha (69 - 130 %) 1,100 - 1,900 ha (21 - 110 %)	>70% NET	>70% Border R/Gwydir	Torrington SCA	30,430	1,481	42.3	M
HSOT	548: NT/3e: Shrublands in the Bolivia Hill area of the New England Tablelands Bioregion	500 (350 - 650) ha 320 - 580 ha (64 - 120 %) 200 - 240 ha (31 - 69 %)	>70% NET	>70% Border R/Gwydir	Bluff River NR Bolivia Hill NR	1,762 1,789	24 198	4.80 39.6	E1 E1
HSOT	561: LC/2b: Shrublands on acid volcanic outcrops in the Severn River region of the western New England Tablelands Bioregion	3,500 (2,500 - 4,500) ha 3,100 - 3,700 ha (89 - 110 %) 1,200 - 2,000 ha (27 - 80 %)	>70% NET	>70% Border R/Gwydir	Kings Plains NP Severn River NR	8,228 5,847	251 1,354	7.17 38.7	M M
HSOT	600: NT/4c: Stringybark She Oak shrubland on acid volcanic outcrops in the Pindari Dam area of the New England Tablelands Bioregion	120 (60 - 180) ha 55 - 160 ha (46 - 130 %) 15 - 45 ha (8.3 - 75 %)	>70% NET	>70% Border R/Gwydir	Severn River NR	5,847	30	25.0	E3
HSOT	611: LC/3e: Grass Tree tall shrubland on shallow basalt soil and talus on the Liverpool Range, BBS Bioregion	200 (140 - 260) ha 140 - 240 ha (70 - 120 %) 65 - 79 ha (25 - 56 %)	>70% BBS	30-70% Hunter/Central R 30-70% Namoi	Coolah Tops NP Towarri NP*	16,220 6,517	10 62	5.00 31.0	E3 M
HSOT	612: NT/5e: Teatree very tall moist shrubland/heathland on sandstone/conglomerate outcrops in the upper Hunter Valley	20 (14 - 26) ha 13 - 23 ha (65 - 120 %) 1 - 1 ha (2.7 - 9.3 %)	<30% BBS >70% SB	>70% Hunter/Central R	Towarri NP*	6,517	1	5.00	E1
MWSI	414: V/5e: White Mallee - Dwyer's Red Gum mallee heath on sands in the Goonoo - Pilliga region, BBS Bioregion	500 (350 - 650) ha 210 - 390 ha (42 - 78 %) 46 - 84 ha (7.1 - 24 %)	>70% BBS	30-70% Namoi 30-70% Central West	Coolbaggie NR Lanes Mill FR Goonoo NP	1,774 731 9,054	50 5 10	10.0 1.00 2.00	E3 E4 E2
MWSI	474: CE/5e: Dwyer's Red Gum - she oak mallee shrubland on eolian sand in the Gilgandra region, BBS Bioregion	400 (200 - 600) ha 35 - 100 ha (8.8 - 25 %) 9 - 27 ha (1.5 - 14 %)	>70% BBS	>70% Central West	Breelong NP	6,840	18	4.50	E3

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MWSR	179: NT/2b: Green Mallee mallee-forest / woodland on stony rises or hills in the Narrabri to Yetman region, BBS Bioregion	2,000 (1,400 - 2,600) ha 1,100 - 1,900 ha (55 - 95 %) 540 - 990 ha (21 - 71 %)	>70% BBS <30% NAN	>70% Border R/Gwydir <30% Namoi	Taringa NR	1,343	5	0.25	E3
					Deriah AA	2,232	44	2.20	M
					Burral Yurrul NR	1,341	120	6.00	E1
					Burral Yurrul NP	1,033	35	1.75	E2
					Terry Hie Hie AA	15,324	560	28.0	E1
MWSR	256: LC/2b: Green Mallee tall mallee woodland on rises in the Pilliga - Goonoo regions, southern BBS Bioeregion	1,300 (910 - 1,600) ha 900 - 1,100 ha (69 - 85 %) 470 - 560 ha (29 - 62 %)	30-70% BBS	30-70% Central West <30% Namoi	Pilliga SCA	33,289	20	1.54	E2
					Coolbaggie NR	1,774	115	8.85	E3
					Goonoo SCA	56,214	100	7.69	E2
					Goonoo NP	9,054	180	13.8	E2
					Biddon SCA	3,349	7	0.54	M
					Breelong NP	6,840	80	6.15	M
					Mogriguy NP	398	13	1.00	E1
MWSR	515: NT/5c: Duri Peak Red Gum woodland on andesite hills of the southern Nandewar Bioregion	300 (150 - 450) ha 150 - 450 ha (50 - 150 %) 0 ha	>70% NAN	>70% Namoi	Not Protected				
RD	547: NT/3b: Wild Quince - Mock Olive - Rusty Fig - lamboto - Sweet Pittosporum dry rainforest of rocky and scree areas of the Nandewar and New England Tablelands Bioregions	1,500 (750 - 2,200) ha 600 - 1,800 ha (40 - 120 %) 300 - 530 ha (14 - 71 %)	>70% NAN <30% NET <30% BBS <30% NNC	30-70% Border R/Gwydir 30-70% Namoi	Gwydir River SCA	3,961	2	0.13	E3
					Horton Falls NP	260	39	2.60	M
					Mount Kaputar NP	51,349	354	23.6	E3
					Bingara SCA	1,971	15	1.00	M
					Kwiambal NP	9,726	5	0.33	E4
RD	616: LC/2b: Grey Myrtle - Rusty Fig dry rainforest in sandstone gorges of the upper Hunter Valley, mainly Sydney Basin Bioregion	4,000 (2,800 - 5,200) ha 2,500 - 4,500 ha (63 - 110 %) 890 - 1,600 ha (17 - 57 %)	<30% BBS >70% SB	>70% Hunter/Central R	Wollemi NP*	500,843	1,240	31.0	E1
					Towarri NP*	6,517	23	0.58	M
RD	627: E/5c: Cooba - Rusty Fig low woodland on limestone outcrops in the Tamworth - Attunga region of the Nandewar Bioregion	25 (18 - 32) ha 11 - 19 ha (44 - 76 %) 0 ha	>70% NAN	>70% Namoi	Not Protected				
RDGI	144: NT/3a: Leopardwood low woodland mainly on clayey soils in the semi-arid zone	350,000 (180,000 - 520,000) ha 75,000 - 220,000 ha (21 - 63 %) 10,000 - 29,000 ha (1.9 - 16 %)	<30% BBS <30% CP 30-70% DRP 30-70% MUL <30% MDD	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Gundabooka NP+	64,134	1,000	0.29	E2
					Narran Lake NR#	28,397	170	0.05	E4
					Nocoleche NR+	71,162	2,000	0.57	E3
					Paroo-Darling NP# +	176,413	7,730	2.21	E2
					Paroo-Darling SCA# +	41,445	9,000	2.57	E2
RDGI	145: V/5a: Western Rosewood - Wilga - Wild Orange - Belah low woodland of the Brigalow Belt South and eastern Darling Riverine Plains Bioregions	200,000 (100,000 - 300,000) ha 25,000 - 75,000 ha (13 - 38 %) 180 - 520 ha (0.06 - 0.52 %)	30-70% BBS 30-70% DRP	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Planchonella NR	723	108	0.05	M
					Dthinna Dthinnawan NP	27,819	200	0.10	E3
					Dthinna Dthinnawan NR#	2,009	30	0.02	M
					Bobbiwaa SCA	2,676	10	0.01	E3
					Trinkey SCA	10,208	2	<0.01	M

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RDGI	146: E/5b: Whitewood low open woodland of the Brigalow Belt South and north-eastern DRP Bioregions	9,000 (4,500 - 13,000) ha 1,300 - 3,700 ha (14 - 41 %) 130 - 370 ha (1 - 8.2 %)	30-70% DRP <30% BBS	<30% Border R/Gwydir <30% Central West <30% Namoi <30% Western	Midkin NR# Narran Lake NR#	374 28,397	2 250	0.02 2.78	M E3
RDGI	439: NT/5e: Mock Olive - Tumbledown Red Gum - Red Ash - Wilga siliceous rocky hill low woodland / shrubland in the Gunnedah - Tambar Springs region, BBS Bioregion	2,000 (1,400 - 2,600) ha 1,400 - 1,600 ha (70 - 80 %) 0 ha	>70% BBS	>70% Namoi <30% Central West	Not Protected				
RDGI	452: E/5a: Mixed vine thicket low eucalypt woodland of the northern-western BBS Bioregion (NSW)	10,000 (5,000 - 15,000) ha 1,000 - 3,000 ha (10 - 30 %) 42 - 76 ha (0.28 - 1.5 %)	>70% BBS	>70% Border R/Gwydir	Terry Hie Hie AA	15,324	59	0.59	M
RG	487: NT/3e: Sweet Pittosporum - Forest Oak - Rough-barked Apple depauparate gully rainforest on the Liverpool Range	200 (140 - 260) ha 120 - 220 ha (60 - 110 %) 31 - 93 ha (12 - 66 %)	>70% BBS <30% NAN	>70% Hunter/Central R <30% Namoi	Coolah Tops NP Crawney Pass NP Towarri NP* Cedar Brush NR	16,220 249 6,517 206	30 7 20 5	15.0 3.50 10.0 2.50	E3 M E3 E4
RIEC	112: V/3b: Black Tea-tree - River Oak - Wilga riparian low forest/shrubland wetland of rich soil depressions in the BBS Bioregion	3,300 (2,400 - 4,200) ha 770 - 1,400 ha (23 - 42 %) 260 - 750 ha (6.2 - 31 %)	>70% BBS <30% NAN	30-70% Border R/Gwydir <30% Central West <30% Namoi	Deriah AA Mount Kaputar NP Bobbiwaa SCA Warialda SCA Terry Hie Hie AA Bingara SCA	2,232 51,349 2,676 2,908 15,324 1,971	13 300 2 5 120 63	0.39 9.09 0.06 0.15 3.64 1.91	M E2 E3 E3 E2 M
RIEC	333: V/5e: Bottlebrush riparian shrubland wetland of the NSW northern NSW South-western Slopes and southern BBS Bioregions	4,000 (2,000 - 6,000) ha 600 - 1,800 ha (15 - 45 %) 2 - 9 ha (0.025 - 0.43 %)	>70% NSS <30% SEH <30% BBS	30-70% Lachlan 30-70% Central West	Nangar NP**	9,363	5	0.13	E3
RIEC	362: V/4b: Weeping Bottlebrush - Rough-barked Apple riparian low open forest / tall shrubland wetland mainly in the Briglaow Belt South Bioregion	2,000 (1,400 - 2,600) ha 560 - 1,000 ha (28 - 50 %) 150 - 170 ha (5.8 - 12 %)	>70% BBS <30% NAN	>70% Border R/Gwydir	Arakoola NR	3,164	160	8.00	E1
RIEC	446: LC/4e: Riparian tea tree - bottlebush - pennywort forbland / shrubland / wetland of montane creeks in the BBS Bioregion	200 (100 - 300) ha 90 - 270 ha (45 - 140 %) 3 - 47 ha (0.83 - 47 %)	30-70% BBS <30% NAN	<30% Border R/Gwydir 30-70% Namoi <30% Hunter/Central R <30% Central West	Coolah Tops NP Mount Kaputar NP Warrumbungle NP	16,220 51,349 23,595	15 5 5	7.50 2.50 2.50	E3 E3 E4

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RIEC	574: V/3a: Tea-tree riparian shrubland / heathland wetland on drainage areas of Nandewar and New England Tablelands Bioregions	14,000 (9,800 - 18,000) ha 2,300 - 4,100 ha (16 - 29 %) 1,100 - 1,800 ha (6.1 - 18 %)	30-70% NAN 30-70% NET <30% NNC	30-70% Border R/Gwydir <30% Namoi 30-70% Northern Rivers	Avondale SCA Bluff River NR Boonoo Boonoo NP Ironbark NR+ Washpool NP Warra NP Single NP Mount Kaputar NP Watsons Creek NR VCA0100	314 1,762 5,525 1,653 69,775 2,021 2,566 51,349 1,392 704	3 30 104 1 1,259 5 2 40 2 1	0.02 0.21 0.74 0.01 8.99 0.04 0.01 0.29 0.01 0.01	E3 M M M M M M E2 E3 M
RSEVT	113: E/5b: Ooline closed forest (dry rainforest) on sandstone and conglomerate rises and hills in the BBS Bioregion	2,500 (2,300 - 2,700) ha 900 - 1,100 ha (36 - 44 %) 70 - 130 ha (2.6 - 5.7 %)	>70% BBS	>70% Border R/Gwydir <30% Namoi	Deriah AA Gamilaroi NR	2,232 118	44 56	1.76 2.24	M M
RSEVT	114: E/5c: Ooline open forest (dry rainforest) on claystone mainly in the Nandewar Bioregion	500 (450 - 550) ha 120 - 130 ha (24 - 26 %) 1 - 3 ha (0.25 - 0.58 %)	>70% NAN	>70% Border R/Gwydir	Gibraltar NR	161	2	0.40	E2
RSEVT	147: E/4a: Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the BBS Bioregion	12,000 (8,400 - 15,000) ha 1,800 - 2,200 ha (15 - 18 %) 350 - 640 ha (2.3 - 7.6 %)	30-70% BBS <30% NAN	>70% Border R/Gwydir <30% Namoi	Bingara SCA Planchonella NR	1,971 723	320 176	2.67 1.47	E2 M
RSEVT	388: V/2c: Rusty Fig - Mock Olive - Red Ash dry rainforest on siliceous substrates in the Warrumbungle and Pilliga Scrub regions, BBS Bioregion	30 (15 - 45) ha 13 - 37 ha (43 - 120 %) 9 - 27 ha (20 - 180 %)	>70% BBS	30-70% Namoi 30-70% Central West	Pilliga East AA Warrumbungle NP Pilliga NR	1,346 23,595 85,354	2 15 1	6.67 50.0 3.33	E3 E3 E2
RSEVT	442: E/5c: Carbeen tall open woodland - Mock Olive tall closed vine thicket on basalt hills in the Northern Basalt sub-region, BBS Bioregion	500 (250 - 750) ha 50 - 150 ha (10 - 30 %) 0 ha	<30% NAN >70% BBS	>70% Border R/Gwydir	Not Protected				
RST	614: NT/2c: Giant Stinging Tree - fig - Socketwood - Red Cedar dry sub-tropical rainforest of the Liverpool Range, BBS Bioregion	70 (49 - 91) ha 35 - 65 ha (50 - 93 %) 20 - 60 ha (22 - 120 %)	<30% NNC 30-70% BBS	>70% Hunter/Central R <30% Namoi	Cedar Brush NR Towarri NP*	206 6,517	25 15	35.7 21.4	E3 E4
RWT	615: LC/2c: Socketwood - Lily Pilly warm temperate rainforest of the Liverpool Range, BBS Bioregion	1,000 (900 - 1,100) ha 720 - 880 ha (72 - 88 %) 530 - 640 ha (48 - 71 %)	<30% SB <30% BBS 30-70% NNC	>70% Huntér/Central R	Towarri NP* Cedar Brush NR Crawney Pass NP Murrurundi Pass NP*	6,517 206 249 215	550 30 1 1	55.0 3.00 0.10 0.10	E1 E3 E1 E1

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SWISL	062: LC/4a: Samphire saline shrubland/forbland wetland of lake beds and lake margins in the arid and semi-arid (hot) zones	50,000 (35,000 - 65,000) ha 32,000 - 58,000 ha (64 - 120 %) 1,700 - 3,000 ha (2.6 - 8.6 %)	<30% DRP 30-70% MUL <30% SSD <30% BBS	>70% Western	Narran Lake NR# Paroo-Darling NP# + Sturt NP+	28.397 176,413 338,672	84 300 2,000	0.17 0.60 4.00	E1 E3 E3
SWISL	212: LC/3a: Chenopod low open shrubland - ephemeral partly derived forbland saline wetland on occasionally flooded pale clay scalds in the NSW North Western Plains	50,000 (25,000 - 75.000) ha 50,000 - 150.000 ha (100 - 300 %) 3,800 - 6,900 ha (5.1 - 28 %)	<30% CP 30-70% DRP <30% BBS	30-70% Central West <30% Namoi 30-70% Western	Culgoa NP# + Narran Lake NR# Toorale NP# +	36,520 28,397 91,527	900 460 4,000	1.80 0.92 8.00	E2 E1 E4
SWISL	363: V/5e: Swamp Paper-bark sodic scald wetland / shrubland of the Yetman - Yalarbon region DRP and BBS Bioregions	300 (210 - 390) ha 140 - 260 ha (47 - 87 %) 5 - 15 ha (1.3 - 7.1 %)	>70% BBS <30% DRP	>70% Border R/Gwydir	Dthinna Dthinnawan NR#	2,009	10	3.33	E3
TDSFEC	492: NT/2a: Silvertop Stringybark - Yellow Box - Apple Box - Rough-barked Apple shrub grass open forest mainly on southern slopes of the Liverpool Range, BBS Bioregion	14,000 (9,800 - 18,000) ha 5,600 - 10,000 ha (40 - 71 %) 1,600 - 2,800 ha (8.9 - 29 %)	>70% BBS	30-70% Namoi 30-70% Hunter/Central R	Coolah Tops NP Cedar Brush NR Towarri NP* Murrurundi Pass NP*	16,220 206 6,517 215	1,500 10 600 100	10.7 0.07 4.29 0.71	E2 E4 E3 E2
TDSFEC	493: NT/4c: Forest Oak - Rough-barked Apple - Silvertop Stringybark shrub grass open forest on protected slopes of the Liverpool Range	1,000 (700 - 1,300) ha 600 - 1,100 ha (60 - 110 %) 120 - 220 ha (9.2 - 31 %)	30-70% BBS <30% NNC <30% NAN	>70% Hunter/Central R <30% Namoi	Coolah Tops NP Crawney Pass NP	16,220 249	50 120	5.00 12.0	E3 M
TDSFEC	620: LC/2a: Sydney Blue Gum - Silvertop Stringybark very tall wet open forest on protected slopes on the Liverpool Range / north coast	35,000 (18,000 - 52,000) ha 14,000 - 42,000 ha (40 - 120 %) 4,200 - 12,000 ha (8.1 - 67 %)	<30% BBS >70% NNC	>70% Northern Rivers <30% Hunter/Central R	Towarri NP* Barrington Tops NP+ Mount Royal NP+ Wingen Maid NR* Cedar Brush NR	6,517 76,799 6,964 1,093 206	100 5,000 3,000 200 5	0.29 14.3 8.57 0.57 0.01	E3 E3 E3 E3 E3
TGFEC	622: NT/3b: Grey Gum - Forest Red Gum - Yellow Box grassy tall open forest on mid-slopes of the Hunter Valley - North Coast escarpment	10,000 (5,000 - 15.000) ha 2,300 - 6,700 ha (23 - 67 %) 760 - 2.200 ha (5.1 - 44 %)	<30% BBS >70% NNC	30-70% Hunter/Central R 30-70% Northern Rivers	Mount Royal NP+ Cedar Brush NR Barrington Tops NP+	6,964 206 76,799	500 5 1,000	5.00 0.05 10.0	E3 E2 E4
TWFEC	495: LC/4e: Brittle Gum - Silvertop Stringybark grassy open forest of the Liverpool Range, BBS Bioregion	300 (210 - 390) ha 180 - 320 ha (60 - 110 %) 15 - 85 ha (3.8 - 40 %)	>70% BBS	>70% Namoi	Coolah Tops NP	16,220	50	16.7	E3
TWFEC	613: LC/1a: New England Blackbutt moist very tall open forest on the southern escarpment of the Liverpool Range to Barrington Tops region, southern BBS to NSW North Coast Bioregions	10,000 (5,000 - 15,000) ha 4,000 - 12,000 ha (40 - 120 %) 1,900 - 10,000 ha (13 - 200 %)	<30% BBS 30-70% NNC 30-70% NET	30-70% Northern Rivers 30-70% Hunter/Central R	Cedar Brush NR Barrington Tops NP+ Mount Royal NP+	206 76,799 6,964	10 5,000 1,000	0.10 50.0 10.0	E3 E3 E3

BBS, NAN & west-NET Bioregions plant communities

A total of 315 plant communities have been classified and assessed as occurring in the BBS, NAN and west-NET Bioregions. A total of 235 plant communities are recorded in the BBS Bioregion, 105 in the NAN Bioregion and 81 in the west-NET Bioregion. Plant community ID number, common name, extent, threat category and protected area occurrences and status are listed in Table 1 ordered by the broadly classified Formation Groups defined in Benson (2006) that are based on the main divisions in Beadle (1981). A total of 267 communities are newly described additions to the plant communities described in Version 2 of the NSWVCA database (Benson 2008). Of these, 263 communities are from the combined BBS, NAN and NET Bioregions complementing 52 communities previously described in the NSW Westen Plains of NSW South-western Slopes that extend into the study area. As a result of new data and feedback on previous versions of the NSWVCA, two communities (IDs 630, 631) have been added to NSW Western Plains and two (IDs 426, 633) have been added to the NSW South-western Slopes Bioregion.

Examples of NSWVCA database full reports and short reports of plant communities are provided in Appendices A–D.

The bulk of the results, i.e. the plant community descriptions, are presented in a range of PDF reports generated from Version 3 of the NSWVCA database. These reports are arranged in folders on the DVD in the back pocket of this journal. They include full (90 field) and short (28 field) All Record Reports covering the 315 plant communities classified in the study area. The full report is 919 pages long. Other PDF reports list the plant communities for Catchment Management Areas and IBRA Bioregions. The DVD contains a "read only" copy of Version 3 of the NSWVCA database that can be used on personal computers to generate a range of full or short reports for listing plant communities by a range of geographical areas and broad vegetation classes as described in the Database Description in Appendix A in Benson (2006). Besides the 20 standard reports available from the opening menu of the NSWVCA database, the database search routine, also accessible from the opening menu, allows the listing of plant communities by common (English) name or scientific (Latin binomial) name. For example, by typing "River Red Gum" in the Common Name field or *Eucalyptus camaldulensis* in the scientific name field a list of 21 River Red Gum communities in NSW is generated. Typing *Eucalyptus albens* in the scientific name field lists 50 plant communities where White Box is a major component of the canopy. As with the standard reports in the database, search results can be printed as PDF or MS Word files with options for full report with references, full report without references or short reports.

With the completion of the classification and assessment of the native vegetation in the BBS and NAN Bioregions reported here, the NSW Western Slopes Section (Figure 8, page 336 Benson 2006) is now complete. Therefore, two of the four sections of NSW are covered in the NSWVCA database with the Tablelands and Coast and Eastern Escarpment Sections remaining incomplete. The DVD contains PDF full and short reports listing the plant communities in the NSW Western Plains Section and the NSW Western Slopes Section.

The contents of the DVD

Folder 1: Version 3 of the NSWVCA database

- A read-only formatted Version 3 of the NSWVCA database and 14 associated files for using the database and the *Images* folder that links to the database. This version of the database includes data entries for the BBS, NAN and west New England Bioregions and updates data entries for the NSW Western Plains and NSW South-western Slopes Bioregions. 585 plant communities are classified for the 11.5 NSW Bioregions covered so far by the NSWVCA project with 315 of these in the BBS, NAN and west New England Bioregions.

Folder 2: Reports on plant communities in the BBS, NAN and west NET Bioregions (Version 3 of the NSWVCA)

- Full (90 fields) and Short (28 fields) All Records Report listing the plant communities in the BBS, NAN and west-NET Bioregions (note: the plant communities recorded for the west-NET Bioregion are those that occur west of the Great Dividing Range);
- Full and Short Reports listing the plant communities in each of the BBS, NAN and west NET Bioregions.
- Full and Short Reports listing the plant communities in the six largest reserves in the area including: Warrumbungle National Park (23450 ha), Mount Kaputar National Park (50255 ha), Coolah Tops National Park (17440 ha), Dthinna Dthinnawan National Park (27780 ha), Torrington State Conservation Area (30050 ha), Goonoo State Conservation Area (53580 ha) and the combined 12 conservation reserves and 14 state forests that comprise the Pilliga Scrub forest (approximately 500,000 ha).

Folder 3: Updated reports on plant communities in the NSW South-western Slopes Bioregion

This updates reports published on the CD in Benson (2008) and includes:

- Full and Short Reports of the 146 plant communities in the NSW South-western Slopes Bioregion;
- Full and Short Reports of plant communities in the Upper Slopes and Lower Slopes sub-regions in the NSW South-western Slopes Bioregion;

Folder 4: NSW Western Slopes Section

- Full and Short Reports on the plant communities in the combined three NSW South-western Slopes, Brigalow Belt South & Nandewar Bioregions that comprise the NSW Western Slopes Section as shown in Figure 8 , page 336 in Benson (2006)

Folder 5: Updated reports on plant communities in the NSW Western Plains and its eight Bioregions

- This updates reports originally published on the CD in Benson *et al.* (2006) and revised in the CD in Benson (2008) and includes:
- Full and Short Reports listing 226 plant communities in the NSW Western Plains Section as shown in Figure 8, page 336 in Benson (2006);
- A sub-folder containing Full and Short Reports of the plant communities in each of the eight IBRA Bioregions that comprise the NSW Western Plains.

Folder 6: Reports on plant communities in nine NSW CMA areas

- Full and Short Reports listing plant communities in the Border Rivers-Gwydir and Namoi CMAs. Version 3 of the NSWVCA covers these areas completely;
- Full and Short Reports listing plant communities in the Western and Lower Murray-Darling CMAs. Version 3 of the NSWVCA covers these areas completely;
- Full and Short Reports listing plant communities in the Murray, Murrumbidgee, Lachlan, Central West and Hunter CMAs. Version 3 of the NSWVCA covers three-quarters of the Lachlan and Central West CMAs, two thirds of the Murray and Murrumbidgee CMAs and the western edge of the Hunter–Central Rivers CMA. Plant communities in the Sydney Basin, South East Highlands, Australian Alps and eastern New England Tableland Bioregions that intersect these CMA areas (see Figure 6, page 335 in Benson 2006) have not yet been classified in the NSWVCA.

Folder 7: NSWVCA Papers and spreadsheet listing all plant communities

- PDF copies of the four NSWVCA published papers including this volume. Note that some of the plant community classifications and distributional and threat/protected area status statistics have changed between version 1 in 2006 to version 3 in 2010;
- MS Excel spreadsheet listing all 585 plant communities so far described in the NSWVCA in 11.5 bioregions of NSW with fields relevant for use in NSW Biometric Tool and Commonwealth Government NVIS databases.
- *Quick Reference Report* of all records from Version 3 in the NSWVCA database containing seven database fields.

Other files on the DVD

- A **READ ME** file describes the contents of the DVD, the 15 files that comprise the NSWVCA database and explains how to use the database. All reports on the DVD are PDF reports generated through a variety of forms developed at the backend of the NSWVCA MS Access database. The folders most relevant to the outputs of Version 3 (this volume) are Folder 1 containing version 3 of the NSWVCA database, Folder 2 containing reports on the BBS, NAN and west-NET Bioregions and part of Folder 6 containing reports on the Border River-Gwydir, Namoi, Central West and Hunter-Central Rivers CMA areas. Folder 7 contains PDF reports of the NSWVCA publications.

The DVD also contains

- an updated bibliography from Version 3 of the NSWVCA database;
- Spreadsheet of major changes made to the NSWVCA records since 2006;
- NSWVCA Version 3 General Description;
- Erratum to Table 1 in Benson (2008).

The plant communities listed in the PDF reports on the DVD are arranged in alphabetical order by the names of the NSWVCA Formation Groups listed in Table 4 on page 346 in Paper One in the NSWVCA series (Benson 2006).

Table 2. Number of plant communities in the BBS, NAN and west-NET Bioregions that are estimated to have been Originally Rare <1000 ha, Originally Restricted 1000 – 10,000 ha and Originally Common >10,000 ha before European settlement.

Estimated pre-European Extent	Community ID Numbers	Number of plant communities
RARE (<1,000 ha)	114, 361, 363, 364, 366, 369, 372, 375, 376, 380, 386, 387, 388, 390, 392, 395, 400, 414, 415, 416, 419, 424, 425, 427, 430, 432, 436, 441, 442, 443, 446, 447, 449, 451, 455, 460, 462, 465, 466, 472, 474, 475, 476, 484, 487, 495, 497, 498, 499, 515, 548, 569, 572, 583, 600, 605, 607, 608, 610, 611, 612, 614, 619, 626, 627	*65*
Restricted (1,000 - <2,000 ha)	256, 384, 389, 391, 410, 428, 450, 463, 471, 482, 493, 511, 520, 521, 525, 545, 547, 576, 580, 581, 615, 617	22
Restricted (2,000 - <5,000 ha)	112, 113, 135, 148, 179, 235, 333, 362, 367, 374, 378, 382, 383, 411, 421, 438, 439, 444, 445, 448, 453, 456, 459, 464, 477, 480, 485, 486, 488, 489, 494, 514, 519, 529, 535, 539, 543, 555, 561, 573, 575, 584, 586, 606, 616, 621, 624, 625, 628, 632	50
Restricted (5,000 - <10,000 ha)	146, 211, 227, 228, 249, 255, 377, 385, 399, 402, 403, 406, 408, 413, 420, 422, 423, 429, 431, 457, 473, 500, 501, 527, 528, 532, 540, 550, 552, 556, 629	31
TOTAL RESTRICTED (1,000 - <10,000 ha)		*103*
Common (10,000 - <20,000 ha)	141, 147, 202, 241, 371, 394, 401, 418, 433, 452, 458, 470, 478, 481, 491, 492, 509, 513, 530, 531, 536, 551, 566, 568, 574, 579, 582, 598, 609, 613, 618, 622	32
Common (20,000 - <50,000 ha)	71, 77, 78. 81, 84, 88, 101, 206, 368, 370, 373, 379, 381, 393, 396, 397, 404, 409, 412, 417, 437, 440, 454, 461, 468, 469, 479, 483, 490, 496, 503, 504, 506, 507, 523, 533, 544, 549, 557, 558, 564, 565, 567, 578, 585, 587, 592, 595, 620, 623	50
Common (50,000 - <100,000 ha)	49, 50, 62, 117, 168, 195, 204, 212, 407, 467, 502, 505, 508, 512, 517, 534, 538, 541, 542, 559, 562, 571, 577, 591, 593, 596, 597	27
Common (100,000 - <200,000 ha)	35, 36; 53, 192, 281, 398, 405, 434, 435, 510, 516, 537, 554, 563, 588, 590, 594, 599	18
Common (200,000 - <500,000 ha)	43, 52, 55, 56, 70, 102, 144, 145, 247, 589	10
Common (>=500,000 ha)	27, 37, 40, 87, 98, 118, 120, 134, 238, 244	10
TOTAL COMMON (>=10,000 ha)		*147*

Range of plant communities

Of the 315 plant communities in the BBS, NAN and west-NET Bioregions, 65 are estimated to have had a pre-European extent <1000 hectares (rare); 103 between 1000 and 10,000 hectares (restricted); and 147 >10,000 hectares (Table 2). The relatively high number of rare communities possibly reflects a number of intricate combinations of substrate and landform that are restricted in area, including wetlands in valleys and shrublands in igneous landscapes.

A total of 42 of the higher hierarchical NSWVCA Formation Groups in NSW (listed in Table 4 on page 346 in Benson 2006) occur in the BBS/NAN/west NET Bioregions (Table 3). The Formation Groups containing the largest number of plant communities are: 55 communities in "*Eucalyptus* (Mostly Shrubby) Woodlands and Forests on Low Fertility Soils on the Western Slopes"; 46 communities in "*Eucalyptus* (Mostly Grassy) Box Woodlands of the Tablelands and Western Slopes"; 29 communities in "*Eucalyptus* Ironbark Woodlands and Forests of the Inland Slopes, Plains and Peneplains"; 16 communities in "Heaths and Shrublands on the Tablelands and Western Slopes of South-eastern Australia"; and 10 communities in "Grasslands on Fine Texture Soils of the Inland Slopes and Plains" (Table 3). This relects the prevalence of shrubby *Eucalyptus* – and *Corymbia*–dominated forests and woodlands and heathlands on sandstones and other silica-rich substrates, grassy woodlands on basaltic and other clay or loam-forming substrates with native grasslands on flat areas with clay to loam alluvial and basaltic fine-textured soils. The area also contains a number of high elevation tall forests in a transition zone to the wetter forests on the NSW east coast and coastal escarpment. The Liverpool Range located in the south of the BBS Bioregion contains inland extensions of typically NET and coastal vegetation types.

A total of 49 of the 99 Vegetation Classes defined in Keith (2004) occur in the BBS, NAN and west NET Bioregions (Table 4). While some of the Keith (2004) Vegetation Classes mainly occur outside these bioregions, this high number of Vegetation Classes indicates the rich diversity of environments in the area.

The occurrence of plant communities in the four CMAs that intersect with the BBS, NAN and west-NET Bioregions are provided in Table 5. The Border Rivers-Gwydir CMA with 196 communities and the Namoi CMA with 223 communities are completely covered by the NSWVCA. Seventy percent of the Central West CMA with 179 communities represented is covered. Approximately 15% of the area of the Hunter-Central Rivers CMA is covered with 54 communities represented. This table also includes a list of communities recorded in the five other western NSW CMAs updating Table 5 in Version 2 of the NSWVCA (Benson 2008). These CMAs are: the Murray CMA with 98 communities being approximately 80% of the plant communties covered; the Murrumbidgee CMA with 124 communities and approximately 65% covered; the Lachlan CMA with 137 communities and approximately 90% covered; the Lower Murray-Darling CMA with 62 communities having complete coverage; and the Western CMA with 156 communities having complete coverage. Note that communities can occur in more than one CMA. The large number of communities in the Namoi CMA, given its relative size, may be explained by the great variation of landscapes in that region. These include the high elevation New England and Liverpool Range woodlands and forests and the diverse plant communities in the Pilliga Scrub, Warrumbungle Range and Mount Kaputar regions.

The main vegetation types in the study area include: extensive ironbark – bloodwood forests and woodlands on sandstones and acid volcanic substrates; hill red gum shrubby woodlands on acid volcanic hills and sandstone hillcrests; green mallee and heaths on aeolian sand and stony hills; *Callitris*-woodlands on sandstone, sand and acid volcanic substrates; *Casuarina* woodlands on alluvial plains and along watercourses; *Allocasuarina* woodlands on siliceous substrates including some communities dominated by Stringybark She Oak (*Allocasuarina inophloia*); *Eucalyptus* grassy woodlands on higher nutrient soils including extensive areas of White Box (*Eucalyptus albens*) woodland on basalt and fine-grained sedimentary substrate; native grasslands on alluvial and basaltic plains; and small areas of wetland in riparian, gilgai and floodplain landscapes. At higher elevations, stringybark-dominated shrubby or grassy open forests occur on hills and tall to very tall *Eucalyptus* shrubby, grassy and ferny open forests and woodlands occur on medium to rich soils on mountain ranges and plateaux dominated by montane or sub-alpine eucalypt "gum" species including *Eucalyptus nobilis*, *Eucalyptus viminalis*, *Eucalyptus dalrympleana* subsp. *heptantha*, *Eucalyptus elliptica*, *Eucalyptus prava*, *Eucalyptus brunnea*, *Eucalyptus pauciflora*, *Eucalyptus stellulata* along with *Eucalyptus nova-anglica* (New England Peppermint). Patches of dry rainforest including semi-evergreen vine thicket and Ooline (*Cadellia pentastylis*) are scattered across the BBS and NAN Bioregions and small areas of warm-temperate and sub-tropical rainforest occur on the southern slopes of the Liverpool Range and near Tenterfield in the NET Bioregion.

Descriptions of the range of plant communities are presented below. These are divided into broad structural classes or geographical areas of native vegetation. While the NSWVCA classification of plant communities is based on full floristic composition, the following summary descriptions mainly refer to dominant canopy species and location. Common names are used after they have first been used in conjunction with a Latin scientific name. Source data supporting the plant communities is generally not cited in this summary but they are available in the detailed plant community descriptions on the DVD in the back pocket of this journal that contains the NSWVCA database and full and short PDF database reports listing plant communities in Bioregions and CMA areas.

Table 3. Cross reference of 315 plant communities in the BBS, NAN and west-NET Bioregions with NSWVCA Formation Groups within this region.
Note: Other plant communities that occur in other bioregions also occur in these Formation Groups.

Formation Group	Acronym	SWS VCA Veg. ID Numbers	No.
Acacia Forests and Shrublands of the East Coast and Tablelands	AST	430	1
Acacia Woodlands and Shrublands of the Inland Slopes and Plains	ASI	27, 35, 77, 118, 120, 134, 135, 372, 389, 390, 445, 476, 629	13
Casuarina Woodlands of the Inland Slopes and Plains	CCI	55, 84, 228, 373, 378, 411, 449, 485	8
Chenopod (Halophytic) Shrublands of the Inland	CHS	168, 195, 211, 377, 466	5
Coast and Escarpment Riparian Forests and Woodlands	CRF	486	1
Cypress Pine (Callitris) Woodlands Mainly of the Inland	CPW	70, 376, 396, 418, 431, 458, 463, 469, 475, 480, 610	11
Eremophila, Melaleuca and Dodonaea shrublands of the inland	EMDI	141	1
Eucalyptus (Mostly Grassy) Box Woodlands of the East Coast Valleys	EBWC	618	1
Eucalyptus (Mostly Grassy) Box Woodlands of the Inland Plains	EBWP	56, 81, 87, 98, 101, 202, 244, 397	8
Eucalyptus (Mostly Grassy) Box Woodlands of the Tablelands and Western Slopes	EBWT	148, 281, 374, 380, 381, 382, 383, 384, 393, 412, 420, 421, 433, 434, 435, 436, 437, 441, 461, 464, 483, 488, 489, 496, 501, 508, 509, 510, 513, 516, 533, 534, 538, 539, 541, 544, 545, 565, 567, 571, 589, 590, 597, 599, 606, 608	46
Eucalyptus (Mostly Shrubby) Woodlands and Forests on Low Fertility Soils on the Eastern Tablelands	EWLFST	502, 503, 504, 505, 512, 514, 523, 536, 537, 550, 556. 557, 558, 559, 568, 575, 583, 584, 585, 605, 609, 626	22
Eucalyptus Communities of Inland Watercourses and Inner Floodplains	EIW	36, 37, 40, 78, 206, 367, 399, 438, 454, 628	10
Eucalyptus Corymbia (Mostly Shrubby) Woodlands and Forests on Low Fertility Soils on the East Coast	EWLFSC	621, 624	2
Eucalyptus Corymbia (Mostly Shrubby) Woodlands and Forests on Low Fertility Soils on the Western Slopes	ESWWS	88, 369, 370, 371, 379, 385, 386, 387, 401, 405, 406, 407, 408, 409, 419, 422, 428, 429, 432, 448, 450, 453, 455, 457, 462, 471, 473, 477, 479, 481, 506, 517, 530, 542, 543, 549, 551, 552, 555, 562, 563, 564, 573, 576, 577, 578, 579, 580, 581, 587, 588, 591, 596, 598, 632	55
Eucalyptus Corymbia Woodlands of the Sub-tropics	EWT	71	1
Eucalyptus Ironbark Woodlands and Forests of the East Coast and Tablelands	EIFC	482, 528, 566, 617, 623	5
Eucalyptus Ironbark Woodlands and Forests of the Inland Slopes, Plains and Peneplains	EIWI	192, 227, 255, 368, 394, 398, 402, 403, 404, 413, 417, 423, 440, 443, 444, 456, 459, 467, 468, 470, 478, 527, 529, 531, 532, 592, 593, 594, 595	29
Eucalyptus Subalpine Woodlands and Forests	ESAW	494, 498, 507, 525	4
Eucalyptus Tall Dry Shrub Forests of the Eastern Coast and Escarpment on Soils of Higher Fertility	TDSFEC	492, 493, 620	3
Eucalyptus Tall Grassy Forests or Woodlands of the Eastern Coast and Escarpment on Soils of Higher Fertility	TGFEC	622	1
Eucalyptus Tall Wet Forests of the Tablelands and Western Slopes	ECT	490, 491, 540, 554, 572, 625	6
Eucalyptus Tall Wet Shrub Forests of the Eastern Coast and Escarpment on Soils of Higher Fertility	TWFEC	495, 613	2
Eucalyptus Woodlands on Rocky Hills of the Inland	EWRHI	424	1
Freshwater Wetlands: Coast, Tablelands and Slopes Sedgeland Swamps	FWSS	582	1
Freshwater Wetlands: Inland Aquatic, Swamp and Shrubland Communities	FWI	53, 238, 241, 247, 361, 364, 375, 400, 410, 416, 447, 465	12
Freshwater Wetlands: Montane and Alpine Freshwater Lakes	FWMAL	500	1

Formation Group	Acronym	SWS VCA Veg. ID Numbers	No.
Freshwater Wetlands: Montane Bogs and Fens	FWMB	497, 607	2
Grasslands of Freshwater Aquatic Habitats of Periodically Flooded Soils	GFAPF	50, 204	2
Grasslands of Montane Regions often Dominated by Poa	GTM	569, 586	2
Grasslands on Fine Texture Soils on the Inland Slopes and Plains	GFTI	43, 49, 52, 102, 395, 427, 451, 484, 511, 619	10
Heaths and Shrublands on the Tablelands and Western Slopes of South-eastern Australia	HSOT	366, 391, 392, 415, 425, 472, 499, 519, 520, 521, 535, 548, 561, 600, 611, 612	16
Hummock Grasslands and Woodlands	HGW	117, 235, 460	3
Mallee Woodlands and Shrublands of Inland Sandplains and Sand Dunes	MWSI	414, 474	2
Mallee Woodlands and Shrublands on Stony Ridges of the Inland Slopes and Plains	MWSR	169, 179, 256, 515	4
Rainforest: Dry	RD	547, 616, 627	3
Rainforest: Gallery	RG	487	1
Rainforest: Semi-Evergreen Vine Forests and Ooline (Cadellia pentastylis)	RSEVT	113, 114, 147, 388, 442	5
Rainforest: Sub-tropical	RST	614	1
Rainforest: Warm Temperate	RWT	615	1
Rainforest-derived Genera Woodlands and Shrublands of the Inland Slopes and Plains	RDGI	145, 146, 439, 452	4
(non-rainforest)	RIEC	112, 333, 362, 446, 574	5
Saline Wetlands: Saline and Clay Lakes (Playas) of the Inland	SWISL	62, 212, 363	3

Table 4. Cross reference of the 315 plant communities classified in the BBS, NAN and west-NET Bioregions in the NSWVCA database with the Vegetation Classes defined by Keith (2004).
Note: Other plant communities that occur in other bioregions also occur in these Vegetation Classes.

Vegetation Class (Keith 2004)	VCA Veg. ID Numbers	Total
Brigalow Clay Plain Woodlands	35. 101, 629	3
Coastal Valley Grassy Woodlands	618, 622, 623	3
Dry Rainforests	388, 547, 616, 627	4
Eastern Riverine Forests	84, 485, 486	3
Floodplain Transition Woodlands	56, 70, 81, 244, 628	5
Gibber Transition Shrublands	118	1
Inland Floodplain Shrublands	241, 247, 375	3
Inland Floodplain Swamps	53, 204, 238, 361, 364, 400, 410, 416, 447, 465	10
Inland Floodplain Woodlands	438, 454	2
Inland Riverine Forests	36, 78, 112, 249, 362	5
Inland Rocky Hill Woodlands	256, 424, 427, 439	4
Inland Saline Lakes	62	1
Montane Bogs and Fens	497, 582, 607	3
Montane Lakes	500	1
New England Dry Sclerophyll Forests	493, 495, 530, 540, 541, 542, 550, 559, 565, 568, 572, 575, 608, 611, 632	15
New England Grassy Woodlands	488, 489, 490, 491, 492, 494, 496, 498, 501, 510, 533, 539, 567, 571	14
North Coast Dry Sclerophyll Forests	481	1
North Coast Wet Sclerophyll Forests	487, 613	2
Northern Escarpment Dry Sclerophyll Forests	626	1
Northern Escarpment Wet Sclerophyll Forests	620	1
Northern Montane Heaths	446, 499, 519, 520, 521, 535, 548, 561, 574	9
Northern Tablelands Dry Sclerophyll Forests	502, 503, 504, 505. 508, 512, 514, 523, 528, 536, 537, 538, 545, 551, 552, 556, 557, 558, 566, 578, 579, 580, 583, 584, 585, 600, 605, 609	28
Northern Tablelands Wet Sclerophyll Forests	392, 625	2
Northern Warm Temperate Rainforests	615	1
North-west Alluvial Sand Woodlands	71, 206, 227, 376, 428	5
North-west Floodplain Woodlands	37, 40, 55, 87	4
North-west Plain Shrublands	77, 144	2
North-west Slopes Dry Sclerophyll Woodlands	228, 380, 381, 382, 384, 385, 386, 389, 390, 391, 393, 394, 412, 413, 429, 432, 435, 453, 506, 517. 527, 529, 543, 549, 555, 562, 563, 564, 573, 587, 588, 591, 594. 595, 596, 597, 598	37
Pilliga Outwash Dry Sclerophyll Forests	88, 141, 148, 397, 411	5
Riverine Chenopod Shrublands	168, 195, 211, 212, 377, 466	6
Riverine Plain Woodlands	27	1

Vegetation Class (Keith 2004)	**VCA Veg. ID Numbers**	**Total**
Riverine Sandhill Woodlands	475	1
Sand Plain Mallee Woodlands	474	1
Semi-arid Floodplain Grasslands	43, 49, 50, 52	4
Stony Desert Mulga Shrublands	120	1
Subtropical Rainforests	614	1
Subtropical Semi-arid Woodlands	117, 146, 192	3
Sydney Hinterland Dry Sclerophyll Forests	612, 621, 624	3
Tableland Clay Grassy Woodlands	507, 513, 525, 534, 554, 606	6
Temperate Montane Grasslands	569, 586	2
Western Peneplain Woodlands	98, 134, 135, 145	4
Western Slopes Dry Sclerophyll Forests	179, 255, 333, 379, 387, 396, 398, 399, 401, 402, 403, 404, 405, 406, 407, 408, 409, 414, 415, 417, 418, 419, 420, 423, 425, 430, 431, 440, 443, 449, 455, 456, 457, 459, 462, 463, 467, 468, 469, 470, 471, 472, 473, 476, 477, 478, 479, 480, 482, 515, 531, 532, 576, 577, 581, 592, 610, 617	58
Western Slopes Grasslands	102, 460, 484, 619	4
Western Slopes Grassy Woodlands	202, 281, 383, 395, 421, 433, 434, 436, 437, 441, 444, 451, 461, 464, 483, 509, 511, 516, 544, 589, 590, 593, 599	23
Western Vine Thickets	113, 114, 147, 378, 442, 445, 452	7
Yetman Dry Sclerophyll Forests	235, 363, 366, 367, 368, 369, 370, 371, 372, 373, 374, 422, 448, 450, 458	15

Table 5. Occurrence of plant communities in NSW Catchment Management Authority areas (CMAs).
Notes. This updates the Western and Lower Murray Darling CMA data published in Table 8 in Version 1 of the NSWVCA (Benson et al. 2006) and the NSW South-western Slopes Bioregion data published in Benson (2008).The Lower Murray-Darling, Western, Border Rivers/Gwydir and Namoi CMAs are fully covered by the NSWVCA. The Central West, Lachlan, Murrumbidgee and Murray CMAs are mostly covered except for the plant communities in the South East Highlands and Australian Alps Bioregions. A limited number of plant communities confined to the upper Hunter part of the Hunter–Central Rivers CMA are included.

CMA & No. Communities	Vegetation Communities Present
Border Rivers-Gwydir 196	27; 35; 36; 37; 39; 40; 43; 49; 50; 52; 53; 55; 56; 71; 78; 84; 87; 88; 98; 101; 102; 112; 113; 114; 115; 135; 144; 145; 146; 147; 148; 158; 161; 168; 179; 181; 182; 192; 195; 202; 204; 205; 206; 211; 214; 227; 228; 235; 238; 241; 242; 244; 247; 281; 362; 363; 364; 366; 367; 368; 369; 370; 371; 372; 373; 374; 375; 376; 377; 378; 397; 409; 413; 418; 421; 422; 427; 428; 429; 430; 431; 435; 436; 437; 441; 442; 443; 444; 445; 446; 447; 448; 449; 450; 451; 452; 453; 454; 460; 466; 500; 501; 502; 503; 504; 505; 506; 507; 508; 509; 510; 511; 512; 513; 514; 516; 517; 519; 521; 523; 525; 527; 528; 530; 531; 533; 534; 535; 536; 537; 538; 539; 541; 542; 543; 544; 545; 547; 548; 549; 550; 551; 552; 554; 556; 557; 558; 559; 561; 562; 563; 564; 565; 566; 567; 568; 569; 571; 572; 573; 574; 575; 576; 577; 578; 579; 580; 581; 582; 583; 584; 585; 586; 587; 588; 589; 590; 591; 592; 593; 594; 595; 596; 597; 598; 599; 600; 605; 606; 607; 608; 609; 610; 619; 628; 632
Central West 180	24; 26; 27; 35; 36; 37; 39; 40; 43; 45; 49; 50; 53; 54; 55; 56; 57; 70; 77; 78; 81; 82; 83; 84; 87; 88; 98; 103; 104; 105; 106; 108; 109; 112; 125; 134; 135; 141; 144; 145; 146; 153; 158; 160; 163; 168; 173; 174; 175; 176; 180; 181; 182; 184; 188; 193; 195; 201; 202; 204; 206; 208; 211; 212; 214; 217; 227; 228; 238; 241; 242; 244; 247; 248; 249; 250; 255; 256; 257; 258; 266; 267; 268; 270; 271; 272; 273; 274; 275; 276; 277; 278; 279; 280; 281; 282; 283; 287; 292; 317; 321; 322; 323; 324; 325; 326; 327; 328; 329; 330; 331; 332; 333; 335; 345; 351; 354; 356; 357; 358; 361; 379; 380; 381; 382; 383; 384; 385; 388; 389; 393; 394; 395; 397; 398; 399; 400; 401; 403; 405; 412; 414; 417; 420; 425; 426; 434; 435; 436; 437; 439; 440; 446; 454; 458; 461; 464; 465; 466; 467; 468; 469; 470; 471; 472; 473; 474; 475; 476; 477; 478; 479; 484; 488; 490; 491; 494; 496; 499; 619
Hunter-Central Rivers 56	42; 116; 281; 383; 403; 436; 437; 446; 461; 467; 476; 478; 479; 480; 481; 482; 483; 484; 485; 486; 487; 490; 491; 492; 493; 494; 496; 497; 498; 499; 501; 507; 510; 522; 524; 540; 541; 554; 563; 571; 582; 611; 612; 613; 614; 615; 616; 617; 618; 620; 621; 622; 623; 624; 625; 626
Lachlan 137	2; 5; 7; 9; 10; 11; 12; 13; 15; 16; 17; 18; 23; 24; 26; 28; 29; 45; 46; 47; 50; 53; 54; 55; 56; 57; 58; 70; 72; 74; 76; 77; 79; 80; 82; 85; 98; 103; 104; 105; 106; 108; 110; 134; 142; 143; 153; 154; 157; 159; 160; 163; 164; 165; 166; 170; 171; 173; 174; 175; 176; 177; 178; 180; 181; 182; 184; 185; 186; 190; 193; 201; 208; 216; 217; 236; 237; 238; 239; 240; 242; 243; 244; 248; 249; 250; 251; 257; 266; 267; 268; 271; 272; 275; 276; 277; 278; 279; 280; 282; 283; 287; 289; 292; 309; 317; 318; 319; 320; 321; 322; 328; 329; 330; 331; 332; 333; 334; 335; 338; 339; 340; 341; 342; 344; 345; 347; 348; 349; 350; 351; 352; 353; 354; 355; 356; 426
Lower Murray/ Darling 62	8; 11; 12; 13; 15; 16; 17; 18; 20; 21; 22; 23; 24; 28; 41; 50; 58; 63; 64; 65; 108; 119; 123; 124; 128; 139; 143; 150; 151; 152; 153; 154; 155; 156; 157; 159; 160; 163; 164; 165; 166; 170; 171; 172; 181; 182; 189; 190; 191; 196; 199; 216; 220; 221; 238; 240; 242; 252; 253; 254; 630; 631
Murray 98	2; 5; 7; 8; 9; 10; 11; 12; 13; 15; 16; 17; 18; 19; 20; 21; 22; 23; 24; 26; 28; 44; 45; 46; 47; 48; 50; 53; 58; 63; 74; 75; 76; 77; 79; 80; 86; 110; 157; 159; 160; 163; 164; 166; 170; 171; 181; 182; 186; 216; 237; 238; 240; 242; 249; 266; 267; 268; 269; 277; 282; 283; 284; 285; 286; 287; 288; 289; 290; 291; 293; 294; 295; 296; 297; 298; 299; 300; 302; 303; 304; 305; 306; 307; 309; 310; 311; 312; 313; 314; 315; 317; 318; 319; 335; 336; 360; 633
Murrumbidgee 125	2; 5; 7; 8; 9; 10; 11; 12; 13; 15; 16; 17; 18; 19; 21; 23; 24; 26; 28; 44; 45; 46; 47; 48; 50; 53; 57; 58; 74; 75; 76; 77; 79; 80; 82; 85; 103; 104; 110; 139; 142; 143; 153; 154; 157; 159; 160; 163; 164; 165; 166; 170; 171; 173; 177; 178; 181; 182; 185; 186; 190; 216; 217; 236; 237; 238; 239; 240; 242; 243; 249; 250; 266; 267; 268; 276; 277; 278; 280; 282; 283; 284; 285; 287; 289; 290; 291; 292; 294; 295; 296; 297; 298; 299; 300; 301; 302; 303; 305; 306; 307; 309; 310; 311; 312; 316; 317; 318; 319; 335; 336; 337; 341; 342; 343; 344; 346; 347; 349; 350; 352; 360; 426; 633
Namoi 223	24; 27; 35; 36; 37; 39; 40; 43; 49; 50; 52; 53; 55; 56; 70; 71; 77; 78; 81; 83; 84; 87; 88; 98; 101; 102; 112; 113; 115; 135; 141; 144; 145; 146; 147; 148; 158; 161; 168; 179; 181; 182; 195; 202; 204; 206; 211; 212; 214; 227; 238; 241; 242; 244; 247; 255; 256; 281; 361; 373; 378; 379; 380; 381; 382; 383; 384; 385; 386; 387; 388; 389; 390; 391; 392; 393; 394; 395; 396; 397; 398; 399; 400; 401; 402; 403; 404; 405; 406; 407; 408; 409; 410; 411; 412; 413; 414; 415; 416; 417; 418; 419; 420; 421; 422; 423; 424; 425; 427; 428; 429; 430; 431; 432; 433; 434; 435; 436; 437; 438; 439; 440; 444; 446; 447; 451; 454; 455; 456; 457; 458; 459; 460; 462; 463; 464; 466; 484; 486; 487; 488; 489; 490; 491; 492; 493; 494; 495; 496; 497; 498; 499; 500; 501; 502; 503; 504; 506; 507; 508; 510; 511; 515; 516; 520; 521; 523; 525; 528; 529; 530; 531; 532; 533; 534; 537; 538; 540; 541; 542; 543; 544; 547; 550; 551; 552; 554; 555; 558; 559; 562; 563; 564; 565; 566; 567; 568; 571; 572; 573; 574; 576; 578; 581; 582; 586; 587; 588; 589; 591; 592; 594; 597; 598; 599; 606; 610; 611; 614; 619; 627; 628; 629
Western 156	11; 13; 15; 16; 18; 23; 24; 25; 27; 29; 31; 35; 36; 37; 38; 39; 40; 41; 43; 50; 52; 53; 55; 56; 57; 58; 59; 60; 61; 62; 63; 66; 67; 68; 69; 71; 72; 77; 82; 87; 98; 100; 103; 104; 105; 106; 108; 109; 115; 117; 118; 119; 120; 121; 122; 123; 124; 125; 127; 128; 129; 130; 131; 132; 133; 134; 136; 137; 138; 139; 140; 142; 143; 144; 145; 146; 149; 150; 151; 152; 153; 154; 155; 156; 158; 159; 160; 161; 162; 163; 165; 166; 167; 168; 169; 170; 171; 172; 173; 174; 175; 176; 180; 181; 182; 183; 184; 189; 192; 193; 194; 195; 197; 198; 199; 200; 207; 208; 210; 211; 212; 213; 214; 215; 218; 220; 222; 224; 225; 226; 229; 230; 231; 232; 233; 234; 238; 241; 242; 244; 245; 246; 247; 250; 257; 258; 261; 262; 263; 264; 271; 359; 375; 376; 377; 466

Plant communities in the Narradool and Moonie-Barwon-Collarenbri Interfluve sub-regions, western BBS Bioregion

These two sub-regions (Figure 3) are inland outliers of the main part of the BBS Bioregion. Occurring in a region with lower rainfall, they contain plant communities more similar with those found in the Mulga Lands or Darling Riverine Plain Bioregions reported in Benson *et al.* (2006). The most common eucalypt-dominated vegetation is ID98, a woodland co-dominated by *Eucalyptus populnea* (Poplar Box) and *Callitris glaucophylla* (White Cypress pine) with *Acacia excelsa* (Ironwood) and a large number of shrub species on red sandy-loam soils and hills with stony outcrops (Figure 6). This grades into *Flindersia maculata* (Leopardwood) low woodland (ID144) on texture contrast clayey soils, Ironwood woodland (ID134) and *Acacia aneura* (Mulga) tall shrubland (ID120) on stony rises and *Eucalyptus melanophloia* (Silver-leaved Ironbark) – *Angophora melanoxylon* – *Triodia mitchelii* (Buck Spinifex) low open woodland hummock grassland (ID117) on deep siliceous sands. Small areas of mixed scrub low open woodland containing small trees such as *Callitris glaucophylla, Acacia salicina, Alstonia constricta, Capparis mitchellii, Geijera parviflora* and *Ventilago viminalis* occur on sand rises near rivers (ID376). On floodplains that lie between hills and stony ranges and on either side of the sub-regions, *Eucalyptus coolabah* (Coolabah) grassy woodland (ID40) and Coolabah-Poplar Box woodland (ID87) predominate with smaller areas of *Eucalyptus largiflorens* (Black Box) woodland (ID37) and Myall Woodland (ID27). Riparian and lacustrine areas such as Narran Lake contain chenopod shrublands (ID211, 212), *Acacia stenophylla* (River Coobah) shrubland (ID241), grasslands (ID43) and wetlands dominated by *Typha* spp. (Cumbungi) (ID182), *Phragmites australis* (Common Reed) (ID181), *Muehlenbeckia florulenta* (Lignum) shrubland (ID247) (Figure 7) and small areas dominated by *Aeschynomene indica* (Budda Pea) and *Echinochloa inundata* (Channel Millet) often with a Coolabah tree overstorey (ID375). A number of chenopod-dominated low shrublands occur on saline flats around Narran Lake (IDs 62, 211, 212 and 377).

Brigalow, Belah and Carbeen woodlands on transitional plains

The Northern Outwash and Pilliga Outwash IBRA sub-regions (Figure 3) occupy a transition zone between the large sandstone regions in the middle of the BBS Bioregion and the alluvial plains in the Darling Riverine Plains Bioregion. These outwash sub-regions mainly contain alluvium or colluvium and include the once widespread and now mostly cleared *Acacia harpophylla* (Brigalow) woodland on gilgai clay soils (ID35), a restricted Brigalow – *Atriplex vesicaria* (Bladder Saltbush) open woodland on texture contrast soils north of the Pilliga forests (ID629) (Figure 8), areas of *Casuarina cristata* (Belah) woodland (ID55) and Belah-

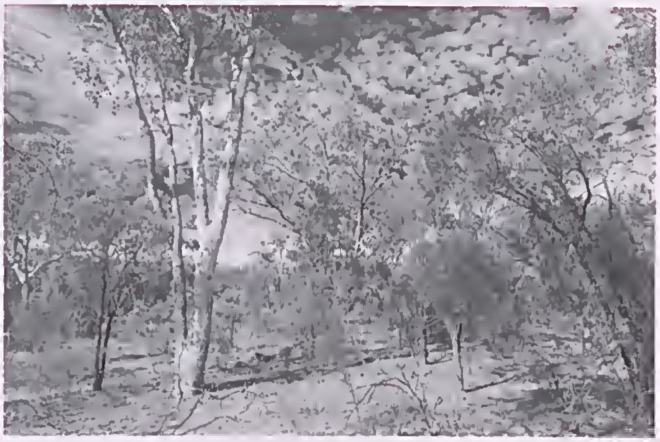

Fig. 6. ID98 *Eucalyptus populnea* (Poplar Box) – *Callitris glaucophylla* (White Cypress Pine) shrubby woodland on red loam on a stony ridge near Lightning Ridge (agd66) 29°40' 42.3"S, 147°47' 52.6"E. Photograph, Jaime Plaza, 30/4/2008.

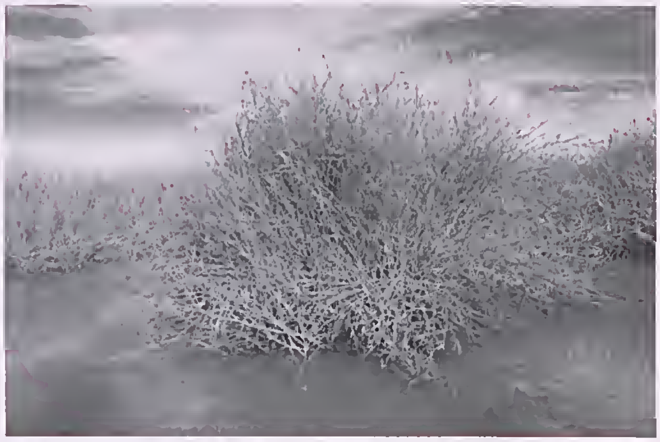

Fig. 7. ID247 *Muehlenbeckia florulenta* (Lignum) shrubland after flood in Clear Lake in Narran Lake Nature Reserve (agd66) 29°42' 56.7"S 147°27' 7.9"E. Photographer, Jaime Plaza, 1/5/2008.

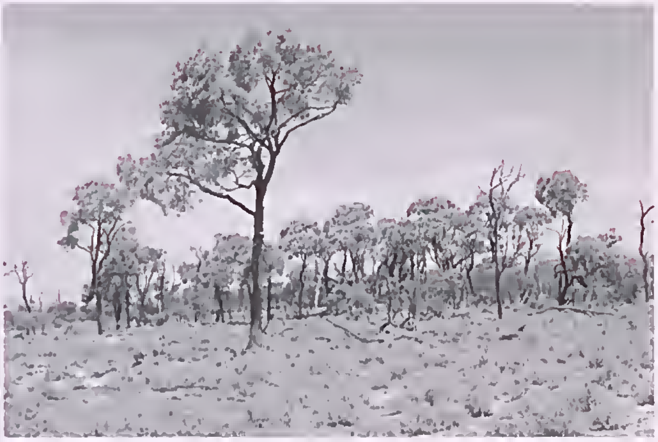

Fig. 8. ID629 *Acacia harpophylla* (Brigalow) with a *Atriplex vesicaria* (Bladder Saltbush) ground cover with *Eremophila mitchellii* on texture contrast soil near Come By Chance (GDA94) 30° 22.95'S 148° 48.86'E. Photographer, D. Robson, 3/11/2009.

Poplar Box woodland (ID56). On alluvial terraces *Corymbia tesselaris* (Carbeen) – White Cypress Pine woodland (ID71) and Silver-leaved Ironbark – White Cypress Pine grassy woodland (ID227) occurs, grading into Carbeen – Coolabah grassy open woodland on alluvial clay soils (ID628). These woodlands grade into *Eucalyptus camaldulensis* (River Red Gum) grassy woodland (ID454), River Red Gum riparian woodland (ID36) or Coolabah woodland (ID40) on floodplains.

Rainforest: dry rainforest (vine thickets and Ooline forest) and Liverpool Range moist rainforest

A small proportion of the study area contains rainforest plant communities grouped as "western dry rainforest" in Keith (2004), semi-evergreen vine thickets (SEVT) in Webb & Tracey (1968) and mostly sub-alliance 32 in the Microphyll Vine Thicket classification of Floyd (1990).

Dry rainforest vegetation is floristically distinct from the ubiquitous *Eucalyptus*-dominated or grass–dominated vegetation that covers most of the area. These small rainforest patches are remnants of an ancient coverage of rainforest across large areas of eastern and southern Australia during wetter geological times and when Australia was positioned at more southern latitudes before the Miocene (White 1986). Based on plot sampling and analysis, Curran (2006) describes five main types of dry rainforest on the NSW North-western Slopes that conform broadly to previous classifications in Floyd (1990) and Benson (1993). The main dry rainforest type termed "semi-evergreen vine thicket" (SEVT) (ID147) (Figure 9) extends north from Gunnedah attaining its greatest species diversity in Planchonella Hill Nature Reserve near North Star, east of Yetman (Williams 1983, Hunter 2006e). SEVT mainly occurs on basalt hills protected from frequent fire, with deep dark loamy soils, and due to this soil fertility this community has mostly been cleared for dryland cropping. SEVT is a listed endangered ecological community (EEC) under the NSW Threatened Species Conservation Act 1995 (TSC Act) and the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act). ID147 grades into several similar communities on different substrates across the BBS and NAN Bioregions. These include: Brigalow viney forest (ID445) near North Star on red loamy soils including basalt, Belah viney woodland (ID378), White Cypress Pine – Poplar Box viney woodland (ID429) on the western edge of the BBS Bioregion, Carbeen viney woodland (ID442) on basalt hills between Bellata and Warialda and Silver-leaved Ironbark woodland (ID598) on sedimentary hills in the BBS and NAN Bioregions. Dry rainforest types that are considerably floristically separate from the SEVT communities listed above include *Ficus rubiginosa* (Rusty Fig) – Red Ash – Mock Olive low woodlands in gullies, scree or protected hill slopes on trachyte or sandstone substrate in the Pilliga to the western Warrumbungle Range region (ID388) and *Alectryon subdentatus* (Wild Quince) – Mock Olive viney

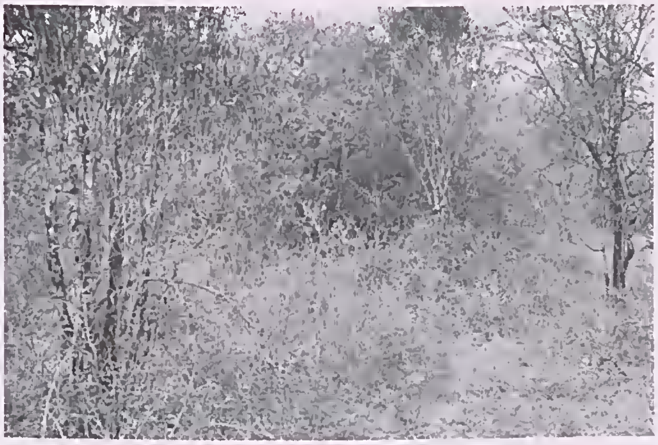

Fig. 9. ID147 Semi-evergreen Vine Thicket on a basalt ridge in Planchonella Hill Nature Reserve near North Star (agd66), 29°8'45.78"S, 150°31'20.82"E. Photographer, Jaime Plaza, 17/11/2007.

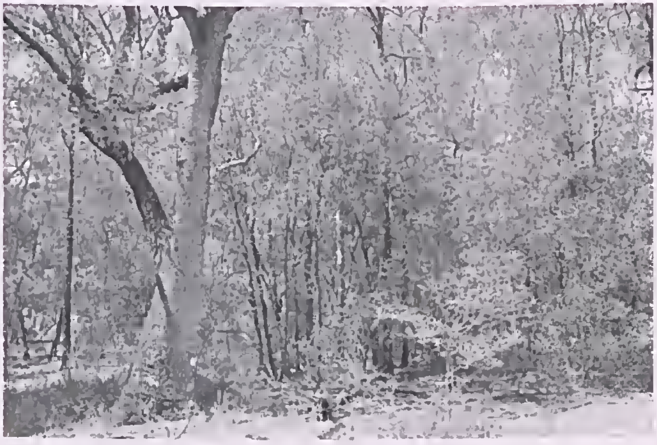

Fig. 10. ID113 A closed to open forest of *Cadellia pentastylis* (Ooline) in Gamilaroi Nature Reserve near Terry Hie Hie. (agd66) 29°50'49.62"S, 150°9'50.82"E. Photographer, Jaime Plaza, 21/11/2007.

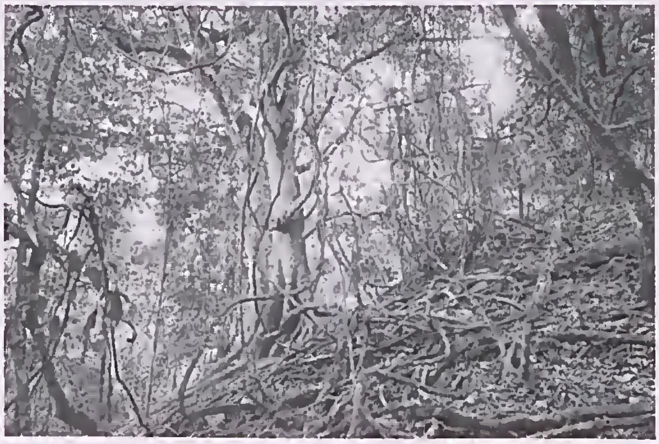

Fig. 11. ID614 Sub-tropical rainforest with *Ficus obliqua* and emergent *Toona ciliata* (Red Cedar) in Cedar Brush Nature Reserve on the Liverpool Range, north of Scone (AGD66) 31°50'44.4"S, 150°41'4.3"E. Photographer, Jaime Plaza, 8/5/09.

low forest / woodland in gullies around Mount Kaputar and elsewhere in the NAN Bioregion. The trachyte plugs in the Garawilla region in the eastern Liverpool Plains subregion contain a distinctive low woodland or tall shrubland dominated by typically dry rainforest tree and shrub species such as *Notelaea microcarpa* (Mock Olive), *Alphitonia excelsa* (Red Ash) with various vines and an overstorey of *Eucalyptus dealbata* (Tumbledown Gum) and *Callitris* spp. (Cypress Pine) (ID439). A patch of *Backhousea angustifolia*-dominated scrub occurs in the Gravesend region.

Two types of the restricted *Cadellia pentastylis* (Ooline) forest are described. ID113 extends from Gunnedah to north of Mosquito Creek near Warialda on lithic sandstone and conglomerate substrates (Figure 10). Besides being dominated by *Cadellia pentastylis* it contains typical SEVT species such as *Carissa ovata* and *Psydrax odorata*, often over-topped by White Cypress Pine and eucalypts such as *Eucalyptus pilligaensis* (Pilliga Box), *Eucalyptus albens* (White Box) and *Eucalyptus melanophloia* (Silver-leaved Ironbark). To the north, in the Mole River and Tenterfield Creek region extending into Queensland, a different Ooline forest occurs on claystone (ID114). This contains less vine thicket shrub species and more of a grassy ground cover.

Wetter types of rainforest occupy protected sites in the south of the BBS Bioregion on the southern slopes of the Liverpool Range. The understory is dominated by a variety of fern species and large-leaved mesic shrub species overtopped by a dense cover of typically east coast NSW rainforest trees. A depauperate gully rainforest occurs in gullies at mid-elevations on the southern slopes of the Liverpool Range including in the Coolah Tops region, dominated by *Pittosporum undulatum* (Sweet Pittosporum), *Melicytus dentatus* (Tree Violet) and (*Myrsine howittiana* (Muttonwood) (ID487). At the eastern end of the Liverpool Range north of Scone, that recieves a higher rainfall than other parts of the BBS Bioregion, more complex rainforest types occupy gullies and sheltered basaltic slopes. Warm Temperate Rainforest dominated by *Daphnandra* sp. A (Socketwood), *Acmena smithii* (Lily Pily), *Alectryon subcinereus* and *Ficus coronata* (Sandpaper Fig) (ID615) is widespread in Towarri National Park. This grades into tiny areas of a sub-tropical rainforest type in Cedar Brush Nature Reserve dominated by *Dendrocnide excelsa* (Giant Stinging Tree), *Ficus obliqua* var. *obliqua* (Small-leaved Fig), *Toona ciliata* (Red Cedar), *Pennantia cunninghamii, Diospyros australis* and *Ehretia acuminata* var. *acuminata* (Koda) (ID614) (Figure 11). At the southern base of the Liverpool Range north of Scone, a sandstone gully rainforest is dominated by *Backhousia myrtifolia* (Grey Myrtle), Rusty Fig, *Alectryon subcinereus* overtopped by dry sclerophyll trees such as *Eucalyptus punctata* (Grey Gum) and *Angophora floribunda* (Rough-barked Apple).

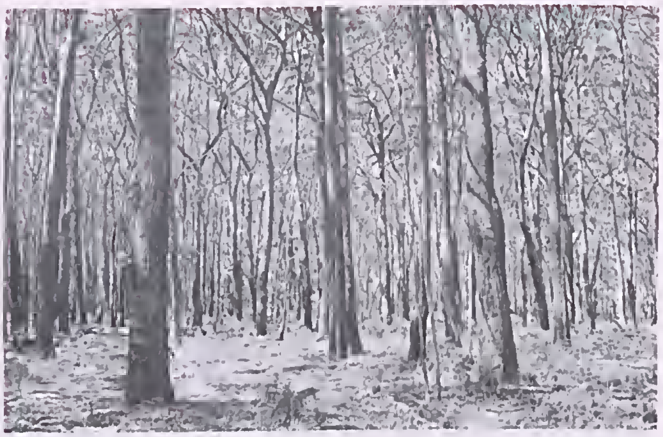

Fig. 12. ID490 *Eucalyptus laevopinea* (Silvertop Stringybark) – *Acacia dealbata – Pteridium esculentum – Poa sieberiana* grass fern tall open forest in Coolah Tops National Park, (AGD66) 31°44' 28"S, 150°0' 21.6"E. Photographer, Jaime Plaza, 24/3/09.

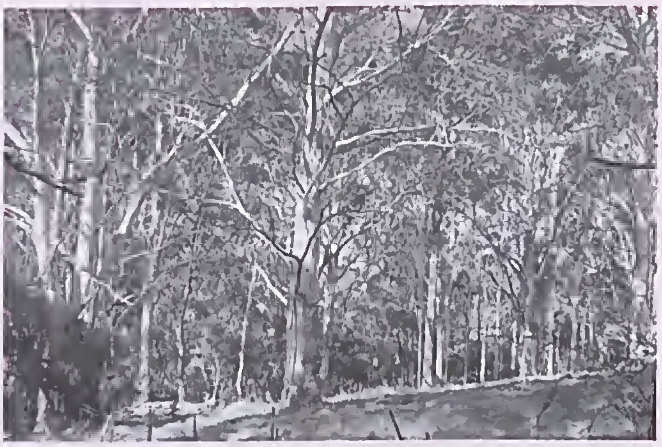

Fig. 13. ID491 *Eucalyptus nobilis – Melicytus dentatus – Acacia melanoxylon* open forest on a basalt mountain in Towarri National Park on the Liverpool Range (AGD66) 31°49'20"S, 150°45'4.9"S. Photographer, Jaime Plaza, 9/5/09.

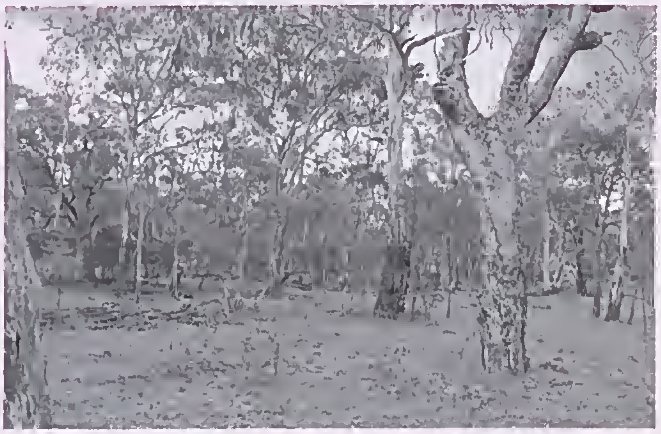

Fig. 14. ID513 *Eucalyptus rubida* subsp. *barbigerorum* (Candlebark) – *Eucalyptus viminalis* (Ribbon Gum) grassy tall woodland of the New England Tablelands, 40km NW of Guyra on Tingha road, (GDA94) 29°56' 39"S 151°23' 55"E. Photographer, P. Richards, 26/10/2007.

Tall forests on high nutrient soils on mountain ranges and plateaux

Tall open forest is present on high nutrient soils at high elevations (800–1300 m) on the New England Tableland, Mount Kaputar and the Liverpool Range. These regions contain the tallest and most moist *Eucalyptus*-dominated forests and woodlands in the study area. The combination of relatively high rainfall and rich soils provides an environment for the development of very tall forests that contrast markedly with the dry woodlands in lower rainfall zones at lower elevations. The main trees species growing in these tall forests are *Eucalyptus laevopinea* (Silvertop Stringybark), *Eucalyptus nobilis* (Mountain Ribbon Gum), *Eucalyptus dalrympleana* subsp. *heptantha* (Mountain Gum), *Eucalyptus viminalis* (Ribbon Gum), *Acacia melanoxylon* (Blackwood) and *Eucalyptus pauciflora* (Snow Gum). The high elevations on the basaltic Liverpool Range, from Coolah Tops National Park in the west to Murrurundi in the east, are dominated by *Eucalyptus laevopinea* tall forest (Figure 12) (ID490), *Eucalyptus nobilis* tall forest (Figure 13) (ID491) grading into *Eucalyptus pauciflora* (Snow Gum) – *Eucalyptus dalrypleana* subsp. *heptantha* tall forest (ID494) with snow grass and shrub ground cover often including vines such as *Smilax australis* or *Clematis glycinoides*. ID492 is a shrubby open forest on the southern slopes of the Liverpool Range containing Silvertop Stringybark and *Eucalyptus melliodora* (Yellow Box). In the Murrurundi area, these tall forests merge with a typically upper coastal escarpment community containing Forest Ribbon Gum, Silvertop Stringybark, Sweet Pittosporum and *Eucalyptus cypellocarpa* (Monkey Gum) (ID625). These tall forests grade into woodlands on the upper northern slopes of the Liverpool Range including a woodland in which Silvertop Stringybark mixes with Yellow Box and *Eucalyptus albens* (White Box) with a grassy understorey (ID488).

In the New England Bioregion large areas of very tall Ribbon Gum – Mountain Gum – Snow Gum grassy open forest or woodland cover basalt regions (ID554) grading into a forest dominated by Silvertop Stringybark – Ribbon Gum – *Angophora floribunda* (Rough-barked Apple) (ID540). These plateau forests grade into Mountain Gum – Ribbon Gum open forest (ID606) in drainage lines in the southern New England Tableland and into drier grassy woodland types such as ID571 that is dominated by Ribbon Gum, Rough-barked Apple and Yellow Box. The restricted *Eucalyptus rubida* subsp. *barbigerorum* (Candlebark) occurs with Ribbon Gum and Snow Gum in a grassy woodland (ID513) (Figure 14) east of Tingha and west of Guyra. Similar forests occur at high elevations on Mount Kaputar in the NAN Bioregion including Silvertop Stringybark – Nandewar Box shrubby open forest (ID550) and Silvertop Stringybark – *Eucalyptus elliptica* (Bendemeer White Gum) – Ribbon Gum open forest (ID572) grading into a sub-alpine montane forest dominated by Mountain Gum and Snow Gum (ID525) (see below).

Two open forests, more typical of mid elevations of the NSW eastern coastal escarpment, occur in the upper Hunter Valley in the southern BBS Bioregion. ID493 is dominated by *Allocasuarina torulosa*, *Angophora floribunda*, *Eucalyptus melliodora* and *Eucalyptus laevopinea*; and ID622 dominated by *Eucalyptus biturbinata* (Grey Gum), *Eucalyptus melliodora* (Yellow Box) and *Eucalyptus tereticornis* (Forest Red Gum).

Sub-alpine – montane grassy woodlands

Sub-alpine woodland is limited to regions of higher elevation (>1000 m) and in plateau valleys subject to cold air drainage. The most ubiquitous subalpine woodland is in the New England Bioregion that contains *Eucalyptus stellulata* (Black Sallee), *Eucalyptus pauciflora* (Snow Gum), *Eucalyptus nova-anglica* (New England Peppermint) and Mountain Gum with a *Poa* (snow grass) ground cover (ID507). This grades into *Eucalyptus nova-anglica* (New England Peppermint) woodland in valleys or on flats composed of basalt and fine-grained sedimentary substrate (ID534) (Figure 15) and New England Peppermint woodland on leucogranite and granite (ID533) on the central plateau of the New England Tableland. A western occurrence of Black Sallee low woodland (ID498) (Figure 16) occurs on the Liverpool Range in the southern BBS Bioregion surrounding basalt plateau swamps. On higher, dry ground a tall forest dominated by Snow Gum (ID494) contains the tallest Snow Gum specimens recorded. A disjunct Snow Gum – Mountain Gum woodland occupies a small area on the top of Mount Kaputar (ID525).

Riparian forests and woodlands

Riparian tree-dominated vegetation includes *Casuarina cunninghamia* (River Oak) tall woodland – open forest (ID84) (Figure 17) in the eastern BBS, across the NAN Bioregion and into the edge of the western NET Bioregion. In the upper Hunter River valley grassy River Oak woodland (ID485) lines creeks and grades into moist ferny River Oak open forest (ID486) in gullies on the southern slopes of the Liverpool Range that in turn grades into either rainforest or Mountain Ribbon Gum forest (ID491). A River Oak woodland grades into riparian *Eucalyptus camaldulensis* (River Red Gum) woodland or forest on the larger rivers (ID78) and into a River Red Gum grassy woodland on floodplains at the western edge of the BBS Bioregion and in the Darling Riverine Plains Bioregion (ID454). On the Liverpool Plains, a mainly cleared and degraded River Red Gum woodland (ID438) containing a grass-sedge ground cover. It lines major watercourses such as Mooki River and Cox's Creek that are composed of alluvial, black earth, basalt-derived soils.

In the central-north NAN and BBS Bioregions, open to dense low open forest dominated by *Melaleuca bracteata* (Black Tea-tree) with River Oak and Rough-barked Apple (ID112) (Figure 18) lines creeks with various substrates,

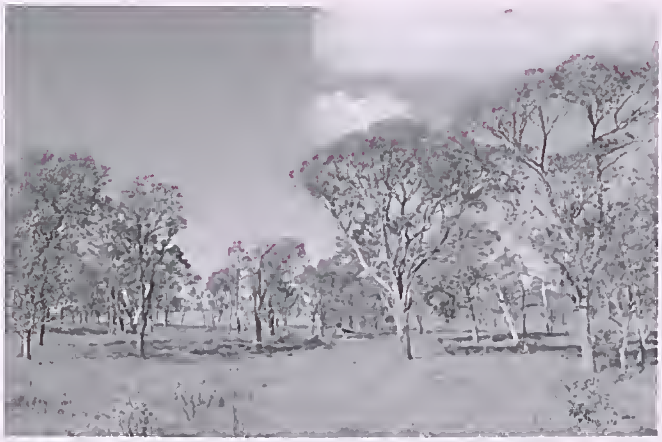

Fig. 15. ID534 *Eucalyptus nova-anglica* (New England Peppermint) grassy woodland on sedimentary substrate in the New England Tablelands near Deepwater (GDA94) 29°26' 22"S 151°50' 04"E. Photographer, P. Richards, 20/02/2008.

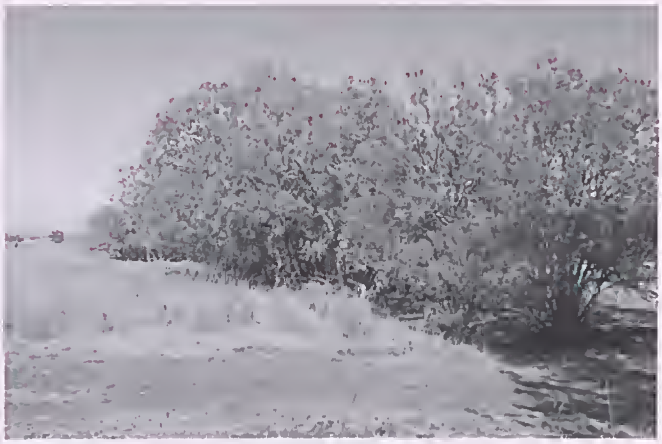

Fig. 18. ID112 *Melaleuca bracteata* (Black Tea-tree) very tall shrubland in a creek near Beresford Park 20 km south-east of Narrabri on soils derived from basalt (AGD66) 30°25' 21"S, 150°2' 23.5"E. Photographer, Jaime Plaza, 28/8/08.

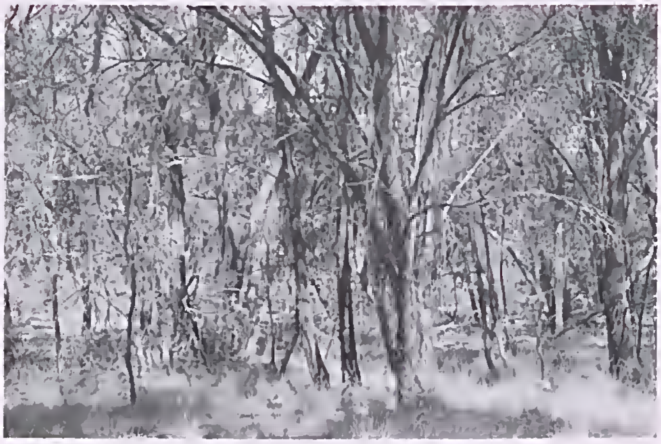

Fig. 16. ID498 *Eucalyptus stellulata* (Black Sallee) low woodland with *Acacia dealbata* and *Poa sieberiana* on edge of valley on a basalt plateau in Coolah Tops National Park (AGD66) 31°44' 43.1"S 150°1' 38.3"E. Photographer, Jaime Plaza, 24/3/09.

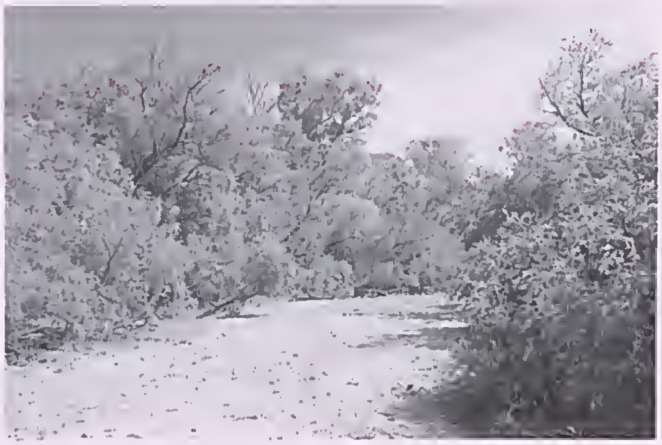

Fig. 19. ID362 *Callistemon viminalis* (Weeping Bottlebrush) riparian shrubland with Rough-barked Apple (*Angophora floribunda*) near Coolatai (AGD66) 29°16'8.7"S, 150°45'23.58"E. Photographer, Jaime Plaza, 18/11/2008.

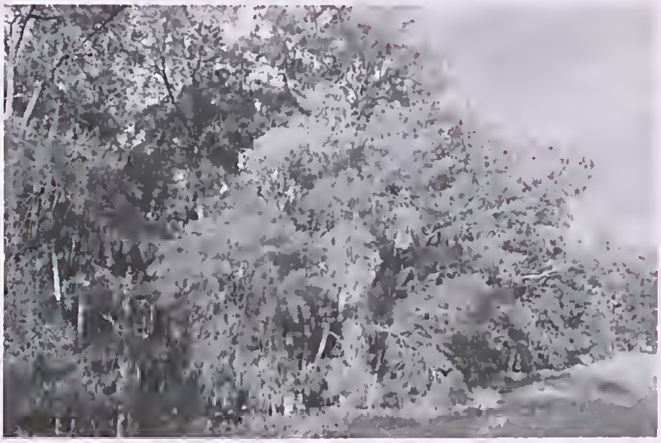

Fig. 17. ID84 *Casuarina cunninghamiana* (River Oak) tall woodland with herbaceous ground cover at Gunderaroo Gap, Warrumbungle NP, (AGD66) 31°22' 3.6"S, 148°57' 26"E. Photographer, Jaime Plaza, 14/09/06.

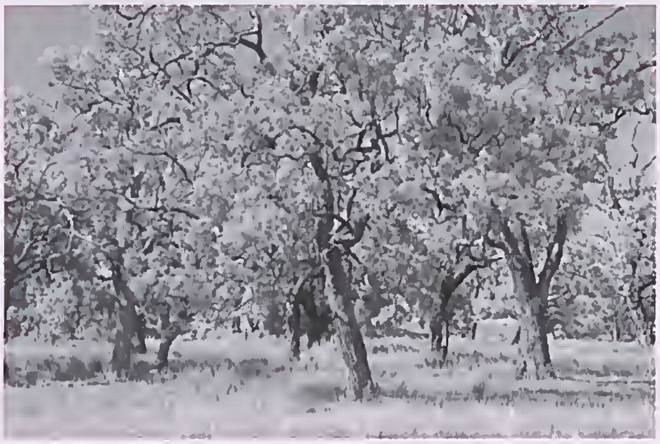

Fig. 20. ID281 *Angophora floribunda* woodland with *Austrostipa verticillata* on an alluvial flat on Garawilla volcanics, east of Coonabarabran (AGD66) 31°9' 42.8"S, 149°40' 18.8"E. Photographer, Jaime Plaza, 17/3/09.

but particularly basalt. A similar and intergrading riparian low forest dominated by *Callistemon viminalis* (Weeping Bottlebrush) and Rough-barked Apple (ID362) (Figure 19) occurs along creeks in the Warialda to Yetman regions in the BBS and NAN Bioregion. Both of these riparian forests are possibly important to native fauna for their high nectar production in the dominant tree species and the natural corridors they provide across mainly cleared agricultural landscapes.

Other riparian forests occur at higher elevations. For example, a woodland composed of *Callitris endlicheri* (Black Cypress Pine), Rough-barked Apple and *Eucalyptus brunnea* (Northern Round-leaved Gum) (ID514) occurs on drainage lines on Mole Granite in the Binghi region near Torrington. Similarly, between Tenterfield and Mole River in the NET Bioregion a Rough-barked Apple – *Eucalyptus amplifolia* (Cabbage Gum) grassy woodland (ID539) occurs on flats near creeks – a community similar to coastal valley woodlands. Rough-barked Apple, *Eucalyptus blakelyi* (Blakely's Red Gum) and *Callitris glaucophylla* (White Cypress Pine) dominate woodland (ID544) on alluvial soils across the upper NAN and west-NET Bioregions. A widespread Rough-barked Apple – Blakely's Red Gum woodland occurs on creek flats and terraces in the BBS Bioregion (ID281) (Figure 20) often grading into River Oak forest (ID84) on stream banks. In the upper Hunter Valley north of the town of Scone, Rough-barked Apple occurs with Blakely's Red Gum and *Eucalyptus punctata* (Grey Gum) along creeks (ID481) intergrading to typical Sydney Basin Bioregion sandstone valley vegetation.

Grassy woodlands on medium to high nutrient soils

Grassy *Eucalyptus*-dominated woodlands or open forests originally covered much of the study area containing deep, high nutrient soils such as alluvial soils, brown to grey clay or loam clay derived from fine-grained sedimentary or metamorphic substrates and black to brown loam to clay soils derived from volcanic substrates. Grassy woodlands typically occur on basalt-derived soils that cover a significant proportion of the area. These landscapes contain plains, low hills or hills landform elements generally with low topographical relief. Due to the combination of the flat terrain and high nutrient soils, these woodlands have mostly been cleared. Initially trees were removed for grazing from the 1830s onwards and increasingly over the 20th Century clearing for cropping has resulted in the loss of native ground cover as agriculture intensified. Most of the grassy woodland plant communities classified in the NSWVCA in the study area are included in Commonwealth and NSW endangered ecological community listings under threatened species laws (Table 9).

Areas of *Alectryon oleofolius* subsp. *elongata* (Western Rosewood) – *Casuarina cristata* (Belah) – *Atalaya hemiglauca* (Whitewood) low woodland (ID145) (Figure 21) occur on colluvial and alluvial clay soils throughout the BBS Bioregion. On the alluvial plains of the Darling Riverine Plains Bioregion and western BBS Bioregion grassy woodland dominated by *Eucalyptus populnea* (Poplar Box) is widespread (ID244). Poplar Box is also a component of grassy woodland / open woodland occurring on cracking clay soils on the Liverpool Plains in the eastern BBS Bioregion (ID101) (Figure 22), a community that shares much of its herbaceous ground cover with the treeless Liverpool Plains grassland (ID102) that occurs in the same IBRA sub-region. A grassy woodland dominated by *Eucalyptus conica* (Fuzzy Box) (ID202) with *Eucalyptus blakelyi, Callitris glaucophylla, Eucalyptus blakelyi* and *Eucalyptus melliodora* (Yellow Box) occurs on alluvial terraces and creek flats north and east of Dubbo including along Baradine Creek in the Pilliga forests. Yellow Box grassy woodland (ID437) occurs throughout the central to southern parts of the BBS Bioregion from Merriwa north often on black earth soils on alluvial valley flats. On sandier alluvial terraces along major watercourse in locations such as in the Pilliga Scrub forests, small areas of Yellow Box occur with *Callitris glaucophylla* (White Cypress Pine) with a grassy ground cover and scattered shrubs such as *Acacia deanei* subsp. *paucijuga, Cassinia arcuata* and *Maireana microphylla* (ID421).

Eucalyptus albens (White Box) dominates a number of grassy woodlands. ID433 occurs on basalt black earth soils on the Liverpool Plains in the BBS Bioregion merging with native grassland (ID102). Similar White Box grassy woodland occurs on basalt in the vicinity of Inverell in the NAN Bioregion (ID590) to the north-east. On fine-grained sedimentary hills in the southern BBS Bioregion, grassy White Box woodland is widespread (ID434) (Figure 23) grading into White Box – White Cypress Pine shrub grass woodland on sandier soils (ID435) where surrounding sandstone substrate influences the soil texture. A derived grassy woodland, primarily due to partial clearing of White Box woodland, is *Brachychiton populneus* subsp. *populneus* (Kurrajong) grassy open woodland (ID436) (Figure 24). Landholders have left the Kurrajong trees because the leaves are palatable as stock feed during drought. Grassy woodlands containing *Eucalyptus blakelyi* (Blakely's Red Gum) covered large areas on medium fertility soils on valley flats and hills. In the BBS and NAN Bioregions Blakely's Red Gum and Yellow Box grassy woodland (ID599) previously covered large areas but is now mainly cleared. Similar woodland (ID510) is located at higher elevations in the NET Bioregion. ID599 and ID510 share floristic and structural characteristics with ID277 in the NSW south-western Slopes Bioregion described in Benson (2008). In the NAN and NET Bioregions areas of *Eucalyptus moluccana*-dominated grassy woodland occur on flats or hills (ID516). Creeklines in the NET Bioregion are dominated by grassy woodland with *Eucalyptus viminalis* (Ribbon Gum), *Angophora floribunda* and *Eucalyptus melliodora* (ID571). West of Guyra in the NET Bioregion grassy woodland is dominated by *Eucalyptus rubida* subsp. *barbigerorum* (Candlebark)

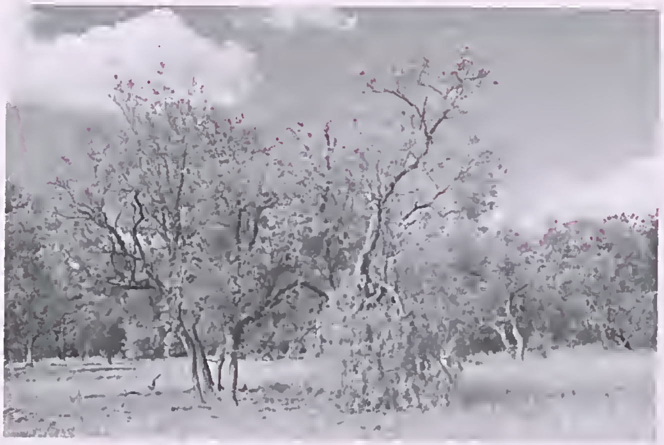

Fig. 21. ID145 *Alectryon oleifolius* (Rosewood) – *Casuarina cristata* (Belah) – *Geijera parviflora* (Wilga) with *Austrostipa* ground cover in TSR near Leard SCA (AGD66) 30°32' 31.7"S, 150°4' 23.8"E. Photographer, Jaime Plaza, 28/8/2008.

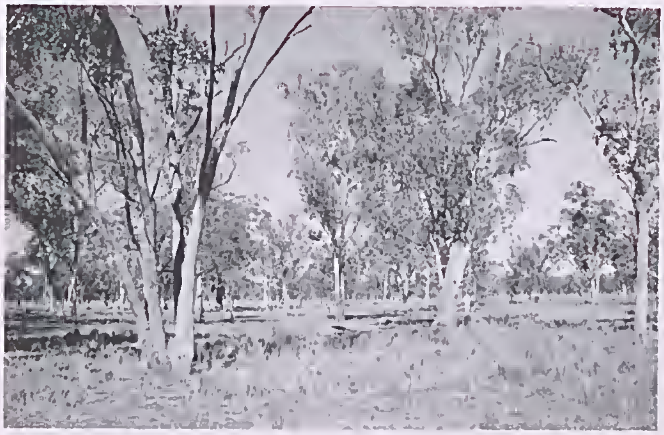

Fig. 22. ID101 *Eucalyptus populnea* (Poplar Box) – *Eucalyptus melliodora* (Yellow Box) – *Austrostipa aristiglumis* grassy woodland on a travelling stock reserve near Gunnedah on the Liverpool Plains, Photographer , J.S. Benson, 2002.

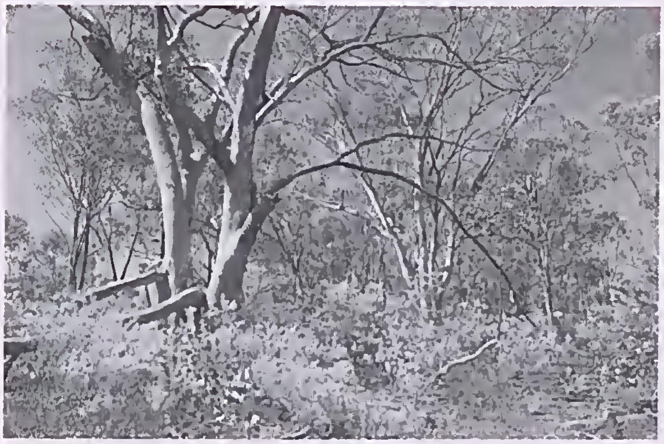

Fig. 23. ID434 *Eucalyptus albens* (White Box) grass – *Acacia decora* woodland on red clay derived from sedimentary substrate in the Coolah Common west of Coolah (AGD66) 31°44' 43"S, 149°34' 46.7"E. Photographer, Jaime Plaza, 19/09/06.

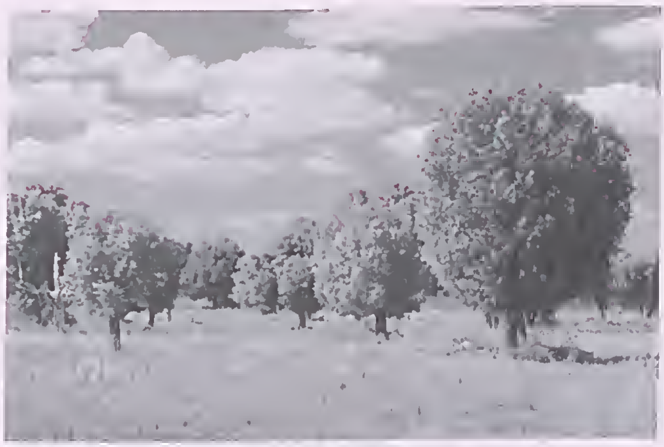

Fig. 24. ID436 *Brachychiton populneus* (Kurrajong) derived open woodland on red loamy clay on hills on Gundea Road north of Mendooran (AGD66) 31°37'2.3"S, 149°2'47.9"E, Photograph, Jaime Plaza,13/5/09.

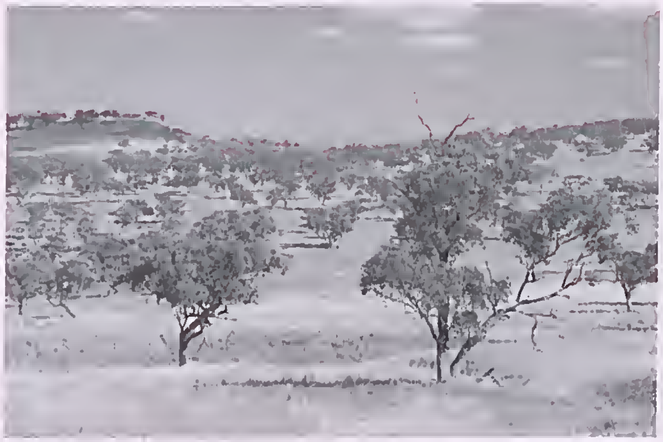

Fig. 25. ID483 *Eucalyptus moluccana* (Grey Box) x *Eucalyptus albens* (White Box) hybrid dominating an open grassy woodland near Cassilis in the upper Hunter Valley (AGD66) 32°2'25"S, 150°0'39.7"E. Photographer, Jaime Plaza, 11/5/09.

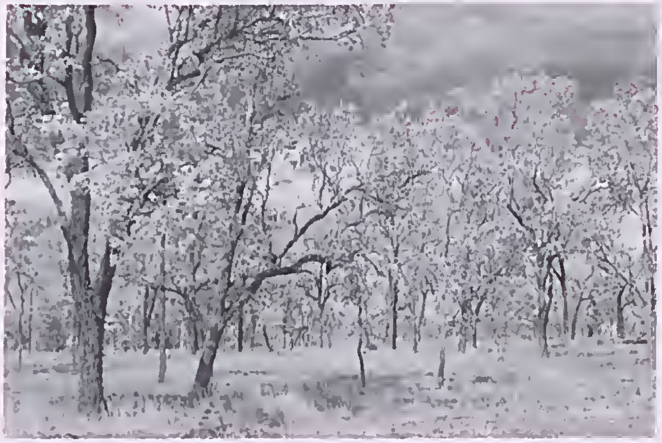

Fig. 26. ID444 *Eucalyptus melanophloia* (Silver-leaved Ironbark) grassy woodland on loam clay soils on alluvial flat on the Yetman - Croppa Road (agd66) 29°19'7.8"S, 150°33'30.3"E. Photographer, Jaime Plaza, 17/11/2009.

with Ribbon Gum, *Eucalyptus pauciflora* (Snow Gum) and *Eucalyptus nova-anglica* (New England Peppermint). At higher elevations in the NET, New England Peppermint woodland is the dominant grassy woodland in montane valleys and plateau flats composed of basalt or fine-grained sedimentary substrates (ID534) (Figure 15). This is mainly cleared and has been and continues to be severely impacted by insect-driven tree dieback. A less threatened type of New England Peppermint grassy woodland occurs on granite and leucogranite substrates (ID533).

The rolling hills composed of basaltic soils around the town of Merriwa in the upper Hunter Valley in the southern-most part of the BBS Bioregion, were once dominated by grassy woodland that is now mostly cleared. This grassy woodland is dominated by an intergrading population of *Eucalyptus moluccana* (Coastal Grey Box) and White Box (*Eucalyptus albens* <–> *moluccana* intermediate) (ID483) (Figure 25). On some valley flats and low rises composed of sedimentary substrates it grades into woodland dominated by Grey Box, Rough-barked Apple and *Eucalyptus tereticornis* (Forest Red Gum) (ID618). Further east along the Hunter Valley near Scone, grassy woodland containing *Eucalyptus crebra* (Narrow-leaved Ironbark) and Coastal Grey Box occurs (ID623). Similar grassy ironbark and Forest Red Gum woodlands occur throughout the Hunter Valley in the Sydney Basin Bioregion, outside the regions covered in this paper.

At higher elevations on hills or mountain ranges such as the Liverpool Range, a widespread grassy woodland contains a mix of *Eucalyptus laevopinea, Eucalyptus nortonii, Eucalyptus melliodora* and *Angophora floribunda* (ID488). At lower elevations also in hill landscapes, a separate grassy woodland (ID489) is dominated by *Eucalyptus goniocalyx* (Long-leaved Box). These hill grassy woodlands grade into montane very tall grassy open forests on the Liverpool Range (ID490, ID491). In the NAN Bioregion White Box, White Cypress Pine and *Eucalyptus melanophloia* (Silver-leaved Ironbark) dominate grassy woodland (ID589) which occurs on hills composed of metamorphosed and sedimentary substrates. Similar grassy woodland dominated by Silver-leaved Ironbark and White Cypress Pine occurs in the far north of the NAN Bioregion (ID593). On basalt or alluvial clay loam soils in the Warialda region, tall grassy woodland dominated by Silver-leaved Ironbark (ID444) (Figure 26) grades into patches of native grassland (ID52). Grassy woodland dominated by *Corymbia tesselaris* (Carbeen) (ID441) occurs in small patches on basalt and enriched sediments between Bellata, Warialda and Yetman.

A distinct type of grassy woodland occurs on a sandy loamy lake lunette east of Gilgandra with a canopy of *Callitris glaucophylla* (White Cypress Pine), *Allocasuarina luehmannii* (Buloke) and *Eucalyptus microcarpa* (Inland Grey Box). This contains a similar tree canopy to the widespread ID80 woodland in the Riverina and NSW South-western Slopes Bioregions.

Open forests and woodlands on granite, acid volcanics and serpentinite in the NAN and NET Bioregions

A range of mostly shrubby woodlands or open forests occur in the belt of hilly country between Tamworth in the south and Tenterfield, Torrington and Ashford in the north in the Nandewar and west-New England Tablelands Bioregions. The main tree species in these communities include the ironbarks *Eucalyptus melanophloia* (Silver-leaved Ironbark), *Eucalyptus caleyi* (Caley's Ironbark), *Eucalyptus sideroxylon* (Mugga Ironbark) and *Eucalyptus crebra* (Narrow-leaved Ironbark); the stringybarks *Eucalyptus macrorhyncha* (Red Stringybark), *Eucalyptus laevopinea* (Silvertop Stringybark), *Eucalyptus youmanii* (Youman's Stringybark), *Eucalyptus mckieana* (Mckie's Stringybark), *Eucalyptus caliginosa* (Broad-leaved Stringybark); as well as *Eucalyptus andrewsii* (Western New England Blackbutt), *Eucalyptus banksii* (Tenterfield Woollybutt), *Eucalyptus albens* (White Box), *Eucalyptus prava* (Orange Gum), *Eucalyptus dealbata* (Tumbledown Gum), *Callitris glaucophylla* (White Cypress Pine) and *Callitris endlicheri* (Black Cypress Pine).

NAN and NET stringybark woodlands and open forests

Eucalyptus macrorhyncha (Red Stringybark) is the main or sole stringybark species in stringybark-dominated plant communities in the NSW South-western Slopes (Benson 2008) and in the drier climes in the BBS Bioregion (e.g. ID379 near Coonabarabran). *Eucalyptus laevopinea* (Silvertop Stringybark) also occurs in the BBS Bioregion but at high elevations on the Liverpool Range (e.g. ID490). In contrast, a greater range of stringybark eucalypt species occur in regions with cooler temperatures and higher rainfall in the NAN and NET Bioregions.

At higher elevations in the central NET Bioregion and mainly east of the Great Dividing Range *Eucalyptus caliginosa* (Broad-leaved Stringybark) dominates the canopy of an open forest with *Eucalyptus melliodora, Eucalyptus bridgesiana* and *Eucalyptus blakelyi* (ID567) and an open forest with *Eucalyptus dalrympleana* subsp. *heptantha* (Mountain Gum) and *Eucalyptus bridgesiana* (Apple Box) (ID568). On the eastern side of the Great Dividing Range species such as *Eucalyptus obliqua* (Messmate) co-dominate tall open forests with *Eucalyptus nobilis* or *Eucalyptus cameronii* on protected hillslopes and *Eucalyptus radiata* (Narrow-leaved Peppermint) along with *Eucalyptus acaciiformis* occur in valleys and flats (Benson & Ashby 2000) but these east New England Tableland forests and woodlands are not described here.

To the west of the higher New England plateau, *Eucalyptus subtilior* and *Eucalyptus williamsiana* are stringybark species occurring on acid volcanic (mainly rhyolite) substrate often with Black Cypress Pine (ID504) or Orange Gum and Caley's Ironbark (ID556). *Eucalyptus subtilior* is also a component of an open forest dominated by *Eucalyptus andrewsii* (Western New England Blackbutt) and *Eucalyptus* *brunnea* (Round-leaved Gum) (ID557) (Figure 27). Another stringybark, *Eucalyptus youmanii* (Youman's Stringybark) occurs with Mountain Gum and Western New England Stringybark in an open forest (ID559) on the western fall of the New England plateau on granite and adamellite. Youman's Stringybark also occurs in an open forest with mixed canopy species including a number of other stringybarks such as Red Stringybark, *Eucalyptus subtilior* and *Eucalyptus mckieana* along with Western New England Blackbutt, Tenterfield Woollybutt and Mountain Gum (ID558). Closely allied to this is an open forest dominated by *Eucalyptus nicholii* (Narrow-leaved Black Peppermint) (ID632) a restricted community occurring on acid volcanic substrate mainly west of Guyra and Armidale. On higher nutrient soils at high elevations, *Eucalyptus laevopinea* (Silvertop Stringybark) tends to be the main dominant stringybark species. In the BBS Bioregion it is a dominant tree species in grassy and wet sclerophyll tall forests on the Liverpool Range (IDs 488, 490, 491, 492, 493, 620, 625). Silvertop Stringybark occurs with *Eucalyptus viminalis* and *Angophora floribunda* in two tall open forest communities in the southern NET / NAN Bioregions (ID540, ID551). An open forest dominated by *Eucalyptus banksii* (Tenterfield Woollybutt) (ID575) occurs on hills in the central to northern NET Bioregion and eastern Mount Kaputar. Open forests dominated by *Eucalyptus volcanica* (Nandewar Box) and *Eucalyptus elliptica* occur on Mount Kaputar (ID550, ID572). In the southern NET and NAN Bioregions, Silvertop Stringybark occurs with *Eucalyptus elliptica* (Bendemeer White Gum), Rough-barked Apple and *Eucalyptus malacoxylon* (Moonbi Apple Box) in a grassy open forest (ID501) (Figure 28) occupying a limited area and it also occurs with *Angophora floribunda* and *Eucalyptus quinniorum* in the Moonbi region (ID552).

Serpentinite outcrops of the Great Serpentinite Belt (Leitch 1980) occur in the NAN Bioregion from near Nundle to Woodsreef. Several plant communities occur on serpentinite including IDs 542, 564 and 591, but one plant community is predominantly confined to this substrate. This is ID573 that contains an unnamed stringybark with affinities to *Eucalyptus macrorhyncha* (Red Stringybark) with *Angophora floribunda* (Rough-barked Apple), White Cypress Pine, Silvertop Stringybark and Silver-leaved Ironbark with an understorey including the hummock grass *Triodia scariosa* subsp. *scariosa* and the grass trees *Xanthorrhoea johnsonii* and *Xanthorrhoea glauca* subsp. *glauca* (Figure 29). This floristically and structurally distinct NSW north-western slopes serpentinite plant community is anotber example of unusual vegetation occurring on serpentinite substrate. Other examples include the distinct mallee – hummock grass (*Eucalyptus serpentinicola – Triodia scariosa*) dominated vegetation at Watchimbark Creek in the eastern Great Serpentinite Belt on the NSW North Coast (Davy & Benson 1995) and the *Allocasuarina verticillata* (Drooping She Oak)-dominated shrubland / woodlands (ID301, 337) described in Benson (2008) from the Coolac – Tumut serpentine in the NSW South-western Slopes Bioregion.

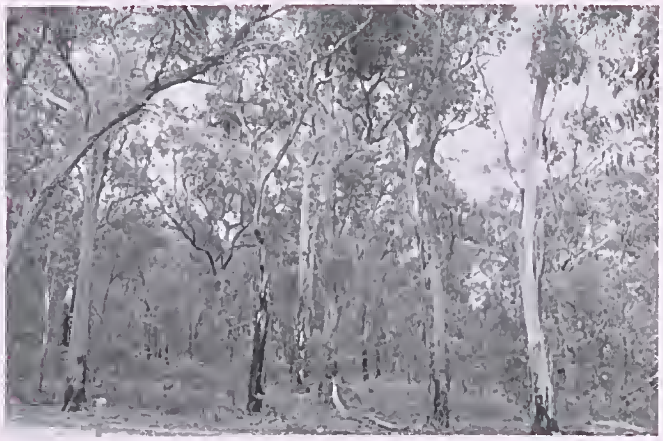

Fig. 27. ID557 *Eucalyptus brunnea* (Round-leaved Gum) with the stringybark *Eucalyptus subtilior* in a shrubby open forest in the Torrington State Conservation Area (GDA94) 29°15' 41"S 151°42' 22"E. Photographer, P. Richards, 19/02/2008.

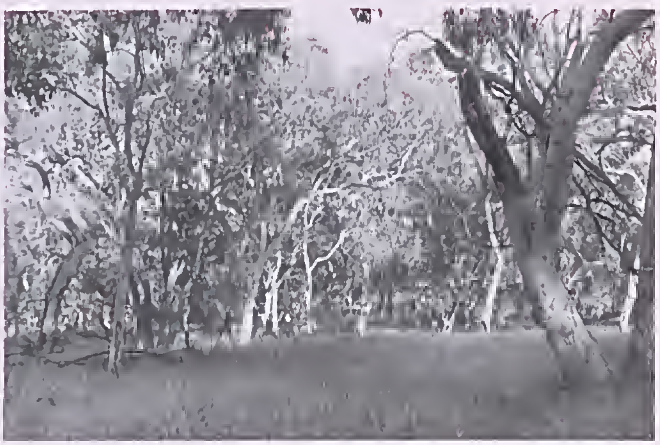

Fig. 28. ID501 *Eucalyptus elliptica* (Bendemeer White Gum) grassy woodland, 2 km N of Bendemeer (GDA94) 30°52' 14"S 151°10' 23"E. Photographer, P. Richards, 15/03/2008.

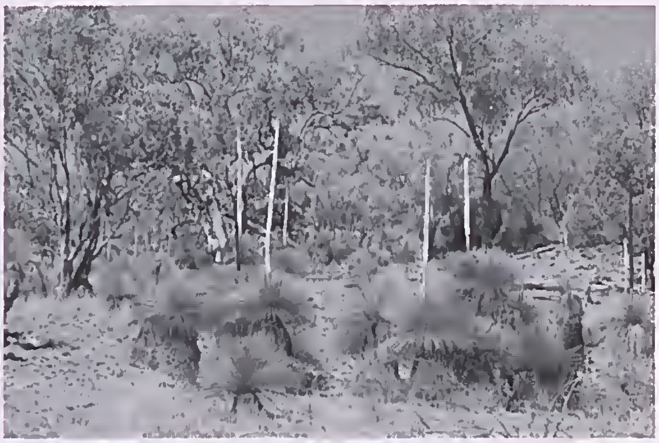

Fig. 29. ID573 *Eucalyptus* sp. aff. *macorhyncha* (stringybark) – *Triodia scariosa* subsp. *scariosa* (spinifex) woodland associated with outcropping serpentinite, 'Kendalla' on Cobbadah – Gulf Creek Road (GDA94) 30°10' 46"S 150°39' 12"E. Photograph, P. Richards, 22/10/2007.

NAN and west-NET Tumbledown Gum and Orange Gum woodlands

Eucalyptus dealbata (Tumbledown Gum) is a major dominant canopy species in low woodlands and woodland on shallow, often rocky soils, on hillcrests and hillslopes in the BBS and NAN Bioregions. Its BBS occurrences are centred on trachyte outcrops on the Warrumbungle Range and in the Garawilla districts. In the NAN Bioregion, Tumbledown Gum is widespread on acid volcanic substrates including trachyte at Mount Kaputar and rhyolite in the Severn River to Ashford region. It also occurs on granite, sandstone and quarzite. In the Mount Kaputar region Tumbledown Gum occurs with the ironbark species *Eucalyptus melanophloia* and *Eucalyptus caleyi* subsp. *caleyi* and the hummock grass *Triodia scariosa* (ID460) on steep, exposed slopes. It also occurs with Black Cypress Pine (ID506) and in heathlands (IDs 520, 521). On rhyolite in the Severn River region, Tumbledown Gum occurs with Black Cypress Pine, Narrow-leaved Ironbark and *Allocasuarina inophloia* (Stringybark She Oak) (ID505) (Figure 30). In the northern NAN Bioregion Tumbledown Gum mixes with White Cypress Pine and Silver-leaved Ironbark (ID596), with Caley's ironbark in the Rock of Gibraltar region near Tenterfield (ID580), with Black Cypress pine, ironbarks and stringybark north of the Severn River (ID578) and with Caley's Ironbark and Black Cypress Pine on extensive hills composed of rhyolite around Ashford near the Queensland border (ID579) grading into occurrences with *Eucalyptus blakelyi* near Bonshaw on granite (ID577). On the western edge of the NET Bioregion, Black Cypress Pine woodland on granite and rhyolite contains Tumbledown Gum as a key canopy component (ID503).

On volcanic sediments on the Melville Range in the southern NAN Bioregion, Narrow-leaved Ironbark occurs with Tumbledown Gum and a shrubby understorey (ID532). Tumbledown Gum occurs with Dwyer's Red Gum and the shrub *Beyeria viscosa* on metasediments between Warialda and Somerton State Forest (ID581). In granite river gorges east of Warialda, Tumbledown Gum is the main tree species in a shrubby open woodland containing shrubs such as *Acacia neriifolia* and *Leptospermum brevipes* (ID453) (Figure 31). A widespread Tumbledown Gum – White Cypress Pine community occurs between Tamworth and Warialda (ID562).

Eucalyptus prava (Orange Gum) is a dominant canopy tree in 12 mostly shrubby plant communities (IDs 502, 503, 512, 535 (Figure 32), 536, 537, 551, 556 (Figure 33), 583, 585, 605 and 609) in the NAN and west-NET Bioregions generally occurring on shallow sandy soils on granite and acid volcanic substrates. IDs 502, 503, 535, 536 and 609 are co-dominated by Orange Gum and Black Cypress Pine on granite with ID535 (Figure 32) and ID609 mainly in the Torrington (Binghi) and Mole Creek granite regions. ID512 contains Orange Gum with Caley's Ironbark on acid volcanics in locations such as Kings Plains National Park. ID537 contains Orange Gum, Caley's Ironbark and Red Stringybark in an open forest in the southern NAN Bioregion and in the same region ID555 contains a community of White Cypress Pine, Orange Gum and *Acacia* species on granite in the Moonbi area. To the north-west, ID551 is co-dominated by Orange Gum, Caley's Ironbark, stringybark species and Tenterfield Woollybutt in a shrubby open forest in the Hortons Creek region north-east of Mount Kaputar and in the upper Rocky Creek catchment. In the northern NET Bioregion ID556 (Figure 33) contains Orange Gum with Caley's Ironbark and the stringybark *Eucalyptus subtilior* in a shrubby open forest on acid volcanics and granite. A highly distinct and restricted plant community occurs on granite outcrops near Tenterfield dominated by *Eucalyptus scoparia* (Wallangara White Gum) with Orange Gum, Western New England Blackbutt (*Eucalyptus andrewsii*) and the wattle *Acacia neriifolia* (ID583) (Figure 34). A sedge-dominated, swampy Orange Gum open woodland occurs on granite near Torrington and in the Single State Forest region on the western edge of the NET Bioregion where the main other tree species is *Eucalyptus youmanii* (Youman's Stringybark) (ID605).

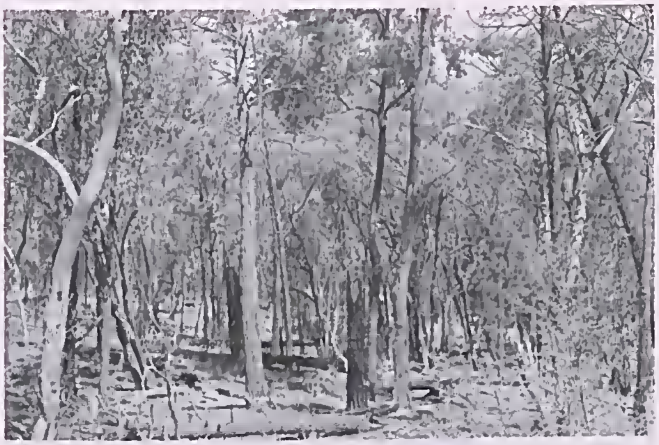

Fig. 30. ID505 *Callitris endlicheri – Eucalyptus dealbata – Eucalyptus crebra* open forest on acid volcanics, Riekeys Lane east of Nullamanna (GDA94) 29°40' 29"S 151°15' 18"E. Photograph, P. Richards, 15/11/2007.

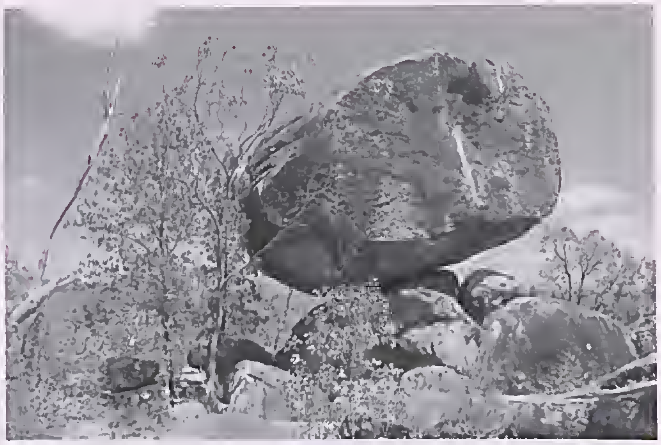

Fig. 31. ID453 *Eucalyptus dealbata - Callitris glaucophylla – Acacia neriifolia – Leptospermum brevipes* low woodland on granite outcrops above Warialda Creek, Cranky Rock Recreational Reserve, east of Warialda (agd66) 29°33'42.78"S. 150°38'51.66"E, Photographer, Jaime Plaza, 20/11/2007.

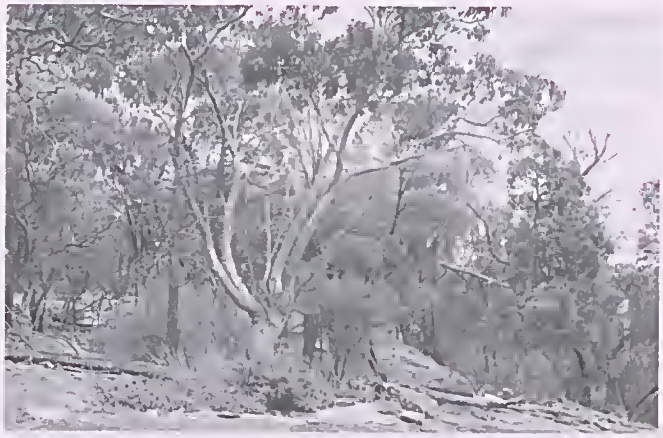

Fig. 32. ID535 *Eucalyptus prava* (Orange Gum) – *Callitris endlicheri* (Black Cypress Pine) heath woodland on outcropping granite in the Torrington area, Torrington State Conservation Area (GDA94) 29°13' 17"S 151°42' 12"E. Photographer, P. Richards, 19/02/2008.

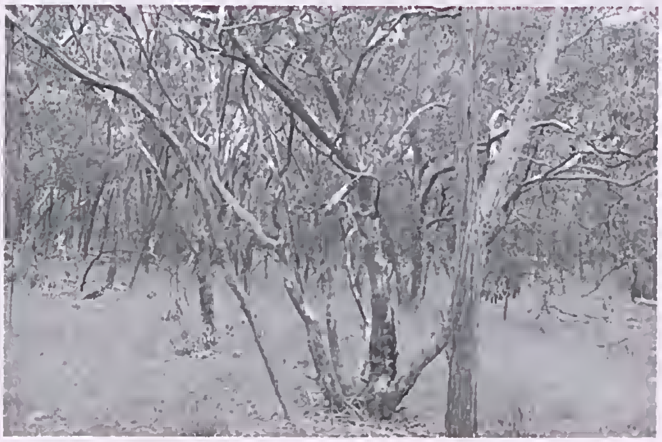

Fig. 33. ID556 *Eucalyptus prava* (Orange Gum) – *Eucalyptus subtilior* (stringybark) open forest of the north-western New England Tablelands in Currys Gap State Conservation Area (GDA94) 29°04' 07"S 151°59' 51"E. Photographer, P. Richards,18/02/2008.

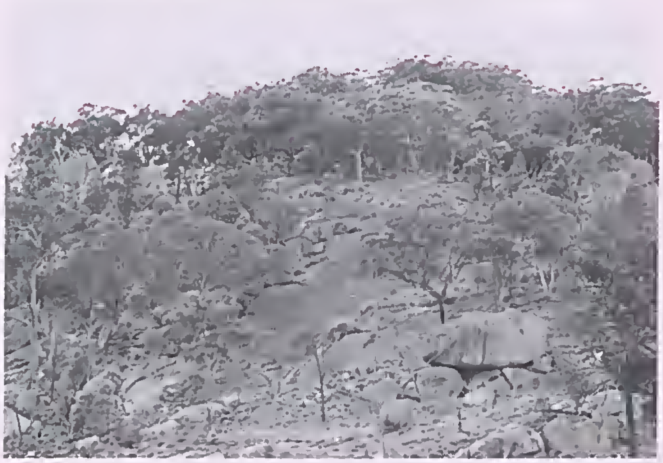

Fig. 34. ID583 *Eucalyptus scoparia* (Wallangarra White Gum) – *Eucalyptus prava* (Orange Gum) open woodland on granite at 'Bald Rock' west of Tenterfield (GDA94) 29°04' 11"S 151°54' 58"E. Photographer, P. Richards, 20/02/2008.

NAN ironbark woodlands and open forests

The main ironbark species in the NAN Bioregion are *Eucalyptus melanophloia* (Silver-leaved Ironbark), *Eucalyptus caleyi* subsp. *caleyi* (Caley's Ironbark), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus sideroxylon* (Mugga Ironbark).

Eucalyptus melanophloia (Silver-leaved Ironbark)-dominated open forests and woodlands occur across the NAN Bioregion with some overlapping into the BBS Bioregion to the west. These include Silver-leaved Ironbark – cypress pine – Stringybark She Oak shrubby woodland in the Yetman – Warialda region (ID371), Silver-leaved Ironbark – Black Cypress Pine – White Box shrubby open forest in the Yetman to Warialda region (ID549), Silver-leaved Ironbark with Caley's Ironbark in the Bingara region (ID564), Silver-leaved Ironbark as a component of the widespread White Box – White Cypress Pine woodland (ID589). Silver-leaved Ironbark also occurs with White Cypress Pine in a widespread open forest from south of Mount Kaputar to the Queensland border (ID594) (Figure 35), with White Cypress Pine and a shrubby understorey including *Leptospermum brevipes* and *Notelaea microcarpa* var. *microcarpa* south of Yetman (ID595) and with White Cypress Pine in a restricted community in the Gibraltar Range area west of Tenterfield (ID593). Silver-leaved Ironbark is a dominant emergent tree with understory elements of viney "dry rainforest" across the western NAN and eastern BBS Bioregions (ID598).

Eucalyptus sideroxylon (Mugga Ironbark) tall woodland or open forest generally occurs on clayey or loamy soils and therefore compared to other ironbark-dominated woodlands or forests it has been widely cleared for agriculture. Consequently, most Mugga Ironbark communities are assessed as threatened. Mugga Ironbark occurs with Black Cypress Pine in a shrubby open forest (ID527) on hills in the northern NAN Bioregion. At higher elevations extending into the NET Bioregion west of Armidale, Mugga Ironbark occur in open forests with Blakely's Red Gum (ID528) and Coastal Grey Box (ID566) both of which have been mainly cleared. On the central to south west-NET Bioregion Mugga Ironbark occurs in an open forest with Narrow-leaved Peppermint and Broad-leaved Stringybark (ID529). Separate Mugga Ironbark open forests occur in the BBS Bioregion described elsewhere.

Eucalyptus crebra (Narrow-leaved Ironbark)-dominated open forest or woodland is rarer in the NAN Bioregion compared to extensive forests on sandstone in the BBS Bioregion. It occurs with Black Cypress Pine and *Acacia cheelii* (Motherumbah) on Mount Kaputar and on the Melville Range north of Manilla (ID332) (Figure 36) and in a widespread shrubby woodland co-dominated by White Box in the southern half of the NAN Bioregion (ID592). Narrow-leaved Ironbark is also conspicuous in woodlands between Ashford and Bonshaw on metasediments.

Shrubby woodlands of the Warrumbungle, Mount Kaputar and Garawilla regions on acid volcanic and sandstone substrates

A diverse range of open forest and woodland occur in the complex topography composed of sandstone and acid volcanic (mainly trachyte) substrates in the Warrumbungle Range – Garrawilla region near Coonabarabran and in the Mount Kaputar region east of Narrabri. A total of 21 plant communities are recorded in the 23 300 hectare Warrumbungle National Park and 27 are recorded in the larger 50 255 hectare Mount Kaputar National Park. Most of the plant communities in these reserves and adjoining mountainous regions are shrubby woodlands but there are also occurrences of grassy woodlands, riparian open forests and shrublands. Extensive areas of woodland / open forest occur on sandstone in the Coonabarabran – Warrumbungle National Park region dominated by *Eucalyptus rossii* (Inland Scribbly Gum), *Corymbia trachyphloia* subsp. *amphistomatica* (White Bloodwood), *Callitris endlicheri* (Black Cypress Pine) and *Eucalyptus macrorhyncha* (Red Stringybark) (ID379) (Figure 37). This last community extends northwards into the southern Pilliga forests.

At higher elevations, *Eucalyptus volcanica* (Nandewar Box), *Eucalyptus macrorhyncha* (Red Stringybark) and *Eucalyptus melliodora* (Yellow Box) dominate the canopy of a shrubby low woodland on hillcrests on the Warrumbungle Range (ID382). This merges with ID384 (Figure 38) a low woodland dominated by *Eucalyptus nortonii* (Norton's Box), Red Stringybark and *Angophora floribunda* with a shrubby understorey that also occurs at Coolah Tops. Both ID382 and ID384 merge with an open woodland of *Angophora floribunda* (Rough-barked Apple), Red Stringybark, *Eucalyptus volcanica* (Nandewar Box) and *Ficus rubiginosa* (Rusty Fig) on scree slopes (ID380) (Figure 39). *Eucalyptus dealbata* (Tumbledown Gum) dominated low woodland occurs on trachyte outcrops throughout the Warrumbungle Range (ID385) (Figure 40) with a more restricted Tumbledown Gum low woodland with a sedge ground cover occurring in areas of water seepage across rock shelves (ID386). White Box-dominated shrubby woodland occurs on the Warrumbungle Range extending south towards Coolah (ID393) (Figure 41). This is dominated by *Eucalyptus albens* (White Box), *Callitris glaucophylla, Angophora floribunda* and *Brachychiton populneus* subsp. *populneus* with common shrub species including *Olearia elliptica* subsp. *elliptica, Notelaea microcarpa* var. *macrocarpa, Cassinia quinquefaria, Acacia implexa* and *Acacia decora.* This community grades into ID420 dominated by *Eucalyptus macrorhyncha* (Red Stringybark) and *Angophora floribunda* (Rough-barked Apple) on upper hillslopes between the Warrumbungle Range and Coolah Tops.

In the Garawilla region, east of Coonabarabran, Rough-barked Apple – Red Stringybark – Black Cypress Pine woodland (ID455) occurs in sandy valleys. Upslope on sandstone substrate ID456 contains *Eucalyptus crebra*

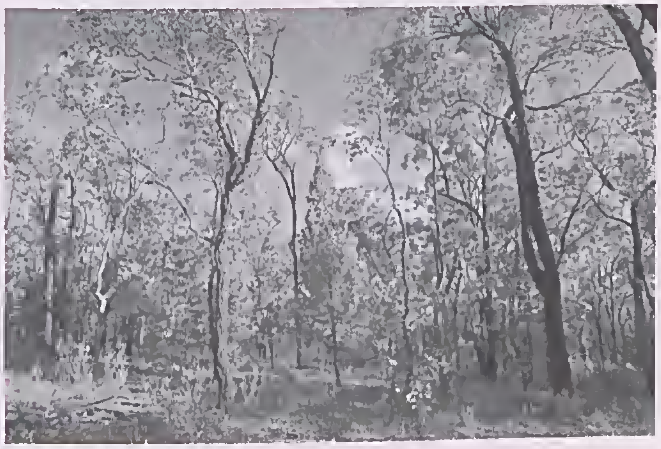

Fig. 35. ID594 *Eucalyptus melanophloia – Callitris glaucophylla* woodland on conglomerate substrate in Leard State Forest (AGD66) 30°34' 76"S 150° 9' 64"E. Photographer, Jaime Plaza, 28/8/2008.

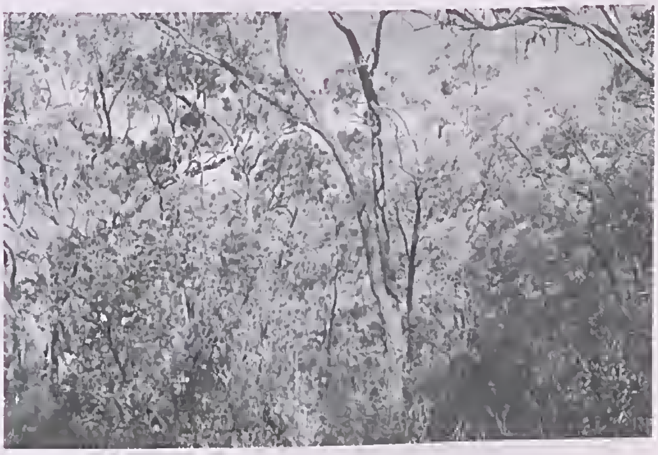

Fig. 36. ID532 *Eucalyptus crebra* (Narrow-leaved Ironbark) shrubby open forest on the Melville Range, Melville Range Nature Reserve (GDA94) 31°05' 06"S 150°36' 29"E. Photographer, P. Richards, 31/03/2008.

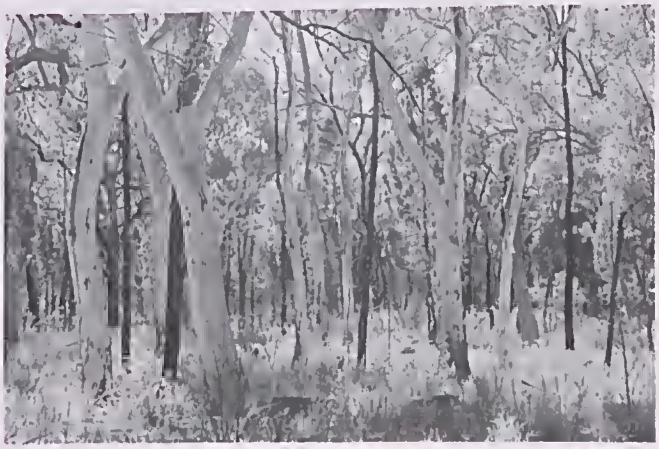

Fig. 37. ID379 *Eucalyptus rossii* (Scribbly Gum) – *Corymbia trachyphloia* (White Bloodwood) on lower hillslope on Burma Road in Pilliga East State Forest (AGD66) 30°47' 7.9"S 149°29' 16.1"E. Photographer, Jaime Plaza, 26/8/2008.

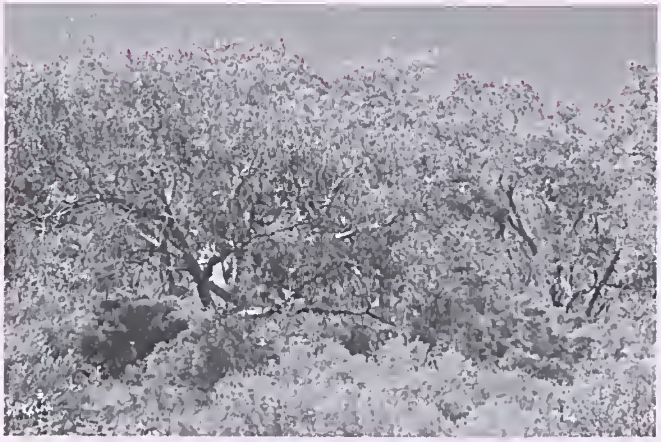

Fig. 38. ID384 *Eucalyptus nortonii* (Norton's Box) low woodland with shrubs *Cassinia quinquefaria* and *Olearia elliptica* on trachyte ridge near Needle Mountain, south of Warrumbungle National Park (AGD66) 31°21' 22"S 149°2' 37.3"E. Photographer, Jaime Plaza, 23/3/09.

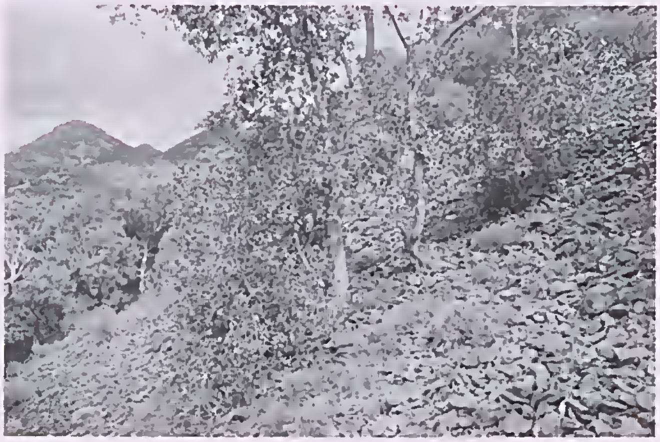

Fig. 39. ID380 Warrumbungles trachyte scree open woodland with *Ficus rubiginosa* (Rusty Fig) at the base of Mount Exmouth, Warrumbungle National Park (AGD66) 31°18' 2.8"S 148°57' 32.4"E. Photographer, Jaime Plaza, 14/09/2006.

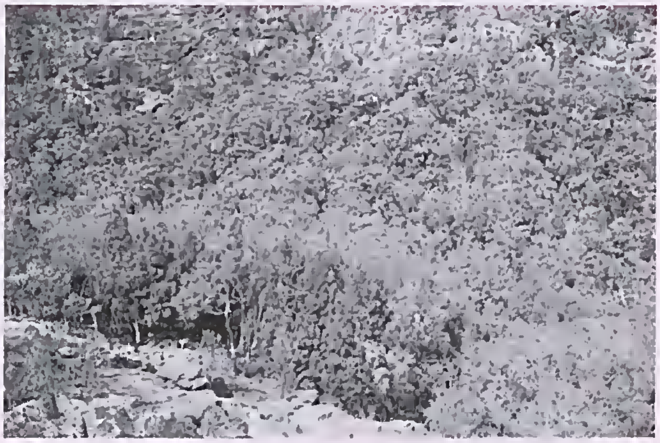

Fig. 40. ID385 *Eucalyptus dealbata* (Tumbledown Gum) – *Callitris endlicheri* (Black Cypress Pine) shrubby low woodland on trachyte outcrop below Split Rock in Warrumbungle National Park (AGD66) 31°17' 25.2"S 148°58' 57.5"E. Photographer, Jaime Plaza, 14/09/06.

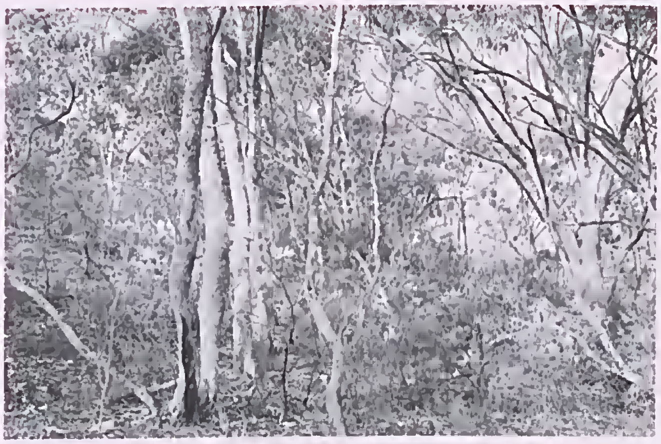

Fig. 41. ID393 *Eucalyptus albens – Callitris endlicheri* shrubby woodland at Gunnermooroo clearing, south-western Warrumbungle National Park (AGD66) 31°20' 43.1"S, 148°57' 40.3"E. Photographer, Jaime Plaza, 14/09/06.

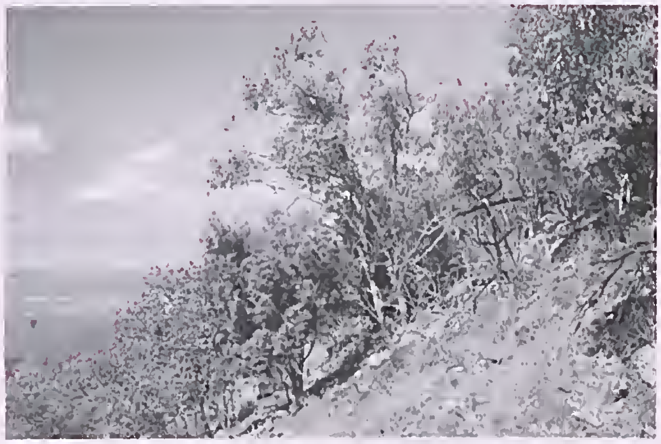

Fig. 42. ID439 *Notelaea microcarpa – Eucalytpus dealbata – Alphitona excelsa* tall shrubland / low woodland on trachyte rocky hills near Mullaley Mountain (AGD66) 31°7'49.6"S, 149°54'19.7"E. Photographer, Jaime Plaza, 6/5/09.

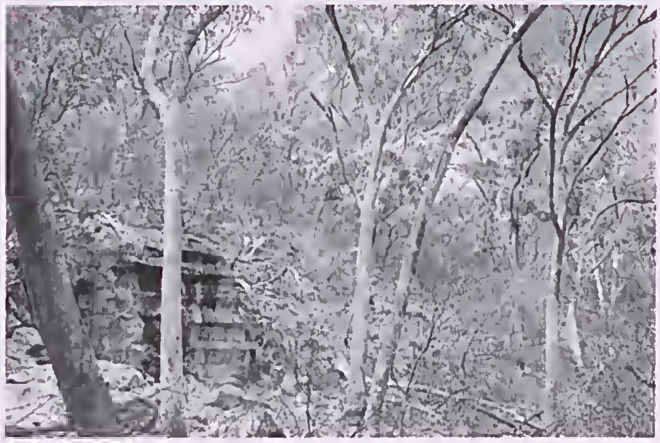

Fig. 43. ID543 *Angophora floribunda – Eucalyptus albens* shrubby open forest in the Kaputar area, Sawn Rocks, Mount Kaputar National Park (GDA94) 30°08' 39"S 150°03' 32"E. Photograph, P. Richards, 13/12/2007.

(Narrow-leaved Ironbark), White Bloodwood and Red Stringybark tall woodland that grades into ID457 on hillcrests dominated by *Corymbia trachyphloia* subsp. *amplistomatica* (White Bloodwood), *Eucalyptus fibrosa* (Red Ironbark) and *Callitris endlicheri* (Black Cypress Pine) (similar to the open forests in the Pilliga Scrub to the north-west). A *Eucalyptus macrorhyncha* (Red Stringybark) – *Corymbia trachyphloia* subsp. *amplistomatica* (White Bloodwood) open forest occurs between Garawilla and Gulgong in the NSW SWS Bioregion On rocky sandstone hillcrests *Eucalyptus dwyeri* (Dwyer's Red Gum) forms a low woodland or open forest (ID462). On trachyte plugs in the Garawilla region east of Coonabarabran a distinctive Tumbledown Red Gum – *Triodia scariosa* (Porcupine Grass) hummock grassland (ID387) occurs on steep hillslopes with skeletal soil. This low woodland grades into a shrubland dominated by mesic species such as Mock Olive, Red Ash and Wilga (ID439) (Figure 42).

Tumbledown Gum shrubby woodland also dominates the canopy of woodland in the Mount Kaputar to Bingara region (ID460) occurring with *Eucalyptus melanophloia* and *Eucalyptus caleyi* (Caley's Ironbark). This community grades into a woodland dominated by Black Cypress Pine, White Box and Tumbledown Gum at mid-elevations on Mount Kaputar (ID506) and into Nandewar Box – *Eucalyptus andrewsii* (Western New England Blackbutt) – Red Stringybark woodland (ID530) at higher elevations there. At lower elevations shrubby White Box woodlands occur on the lower slopes of the Nandewar Range (ID543 & ID587). On Mount Kaputar, Black Cypress Pine mixes with White Box and Tumbledown Gum in shrubby open forest (ID506). A similar community dominated by Black Cypress pine and Dwyer's Red Gum also occurs on sandstone outcrops at the foot of the Nandewar Range (ID610). On rocky slopes Rough-barked Apple occurs with White Box and occasionally Rusty Fig (ID543) (Figure 43). A *Eucalyptus crebra* (Narrow-leaved Ironbark) – *Callitris endlicheri* (Black Cypress Pine) – *Eucalyptus dwyeri* open forest (ID531) also occurs on the Nandewar Range.

Ironbark and bloodwood shrubby open forests and woodlands on sandstone substrates, mainly BBS Bioregion

One of the main features of the vegetation of the NSW north western slopes is the array of ironbark and bloodwood eucalypt-dominated woodlands and open forests occurring on sandstone or conglomerate substrates including extensive outcrops of Pilliga Sandstone. The main occurrences include the Goonoo forest region north of Dubbo, the Pilliga Scrub forests between Coonabarabran and Narrabri, a series of forests north of Narrabri to Terry Hie Hie to Warialda and forest areas between Warialda to Yetman and the Queensland border. Although similar tree canopy species occur over the full range, the understorey alters considerably, yielding multiple woodland or forest assemblages as indicated in the results of the extensive plot based analysis in RACAC (2004) which formed a basis for this NSWVCA classification of these forests.

Forests in the Dubbo-Goonoo-Mendooran region

One of the most ubiquitous ironbark forests in the southern BBS Bioregion occurring on sandstone rises in Goonoo forests (several conservation reserves and state forests) north of Dubbo is ID467 (Figure 44) dominated by *Eucalyptus nubila* (Blue-leaved Ironbark) (and *E. nubila x fibrosa*), *Callitris endlicheri* (Black Cypress Pine) and *Eucalyptus dwyeri* (Dwyer's Red Gum) with a rich array of shrub species. A similar forest dominated by *Eucalyptus fibrosa* (Red Ironbark), often with *Acacia lineariifolia* (Narrow-leaved Wattle) (ID478), occurs between Mendooran and Gulgong extending into the upper Hunter Valley. The structure and floristic composition of these forests vary with time since fire but generally they contain a mid-dense shrub layer and limited ground cover. On deeper soils on flatter terrain, a tall open forest dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark) with *Callitris endlicheri*, *Eucalyptus blakelyi* and *Allocasuarina luehmannii* (Buloke) (ID468) (Figure 45) is widespread often grading into ID467 on sandstone rises and into the less common *Eucalyptus sideroxylon* (Mugga Ironbark) dominated open forest (ID470) in a few locations. Two other Mugga Ironbark woodlands occur in the southern BBS Bioregion. Around Dubbo, Mugga Ironbark – *Eucalyptus pilligaensis* (Pilliga Box) woodland (ID255) occurs in mainly cleared landscapes and to the east of Mendooran. On hillcrests in the vicinity of Dapper Nature Reserve, Mugga Ironbark occurs with Inland Grey Box in a grassy-low shrub woodland (ID403) (Figure 46). Interspersed throughout the Goonoo region ironbark forests are communities dominated by White Cypress Pine (*Callitris glaucophylla*) with Narrow-leaved Ironbark, Buloke and *Eucalyptus microcarpa* (ID469). A White Cypress Pine-dominated woodland containing White Box, Buloke and *Acacia cheelii* extends to the edge of the Liverpool Plains (ID458). Throughout the BBS Bioregion, from north of Dubbo, patches of *Eucalyptus pilligaensis* (Pilliga Box) tall woodland are present on brown loamy soils (ID88) (Figure 47). A shrubby red gum forest occurs on sandy soils throughout the Goonoo forests, dominated by *Eucalyptus chloroclada* (Dirty Gum) (ID473). On rocky sandstone hillcrests, Dwyer's Red Gum occurs with Black Cypress Pine and various ironbark species (ID471). Creek lines contain the riparian red gum forest (ID399) with small areas of sedgeland (ID400). On deep sands the forests grade into *Melaleuca uncinata* (Broombush) shrubland (ID141) and on stony rises Green Mallee often dominated (ID256) (see below). Shrubby White Box – cypress pine woodland (ID412) occurs between Mendooran and the southern Pilliga forests to the north.

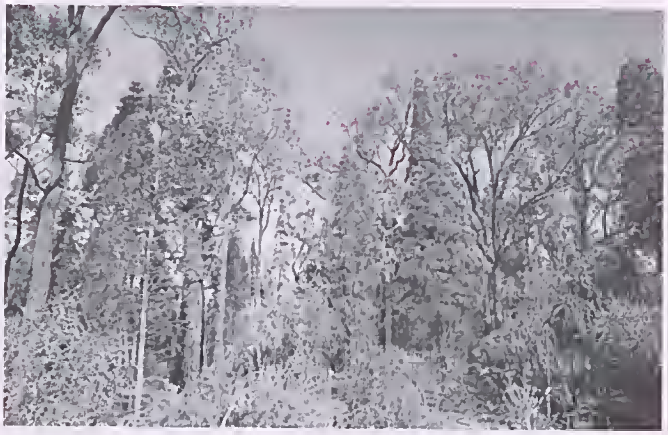

Fig. 44. ID467 *Eucalyptus nubila – Callitris endlicheri* open forest in Goonoo State Conservation Area (agd66) 32°0’ 30.3” S 148°47’ 32.1”E. Photographer, Jaime Plaza, 07/05/2005.

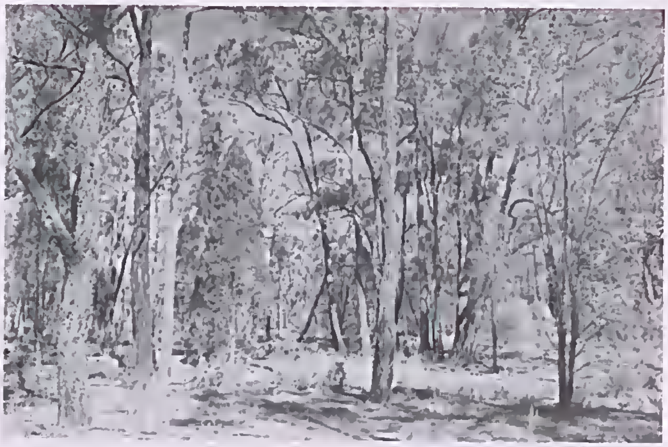

Fig. 45. ID468 *Eucalyptus crebra – Callitris endlicheri – Daviesia acicularis – Allocasuarina diminuta* open forest on a sandstone ridge on the Mendooran – Dubbo Road in Goonoo State Conservation Area (AGD66) 31°54’32.8”S, 149°2’24”E. Photographer, Jaime Plaza, 13/5/09.

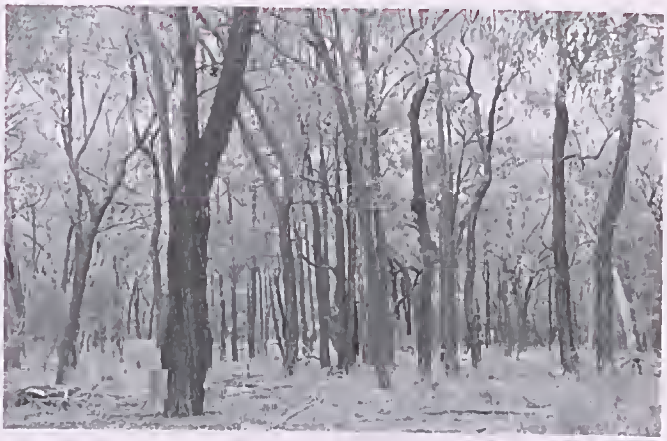

Fig. 46. ID403 *Eucalyptus sideroxylon – Callitris endlicheri – Eucalyptus fibrosa* open forest in Dapper Nature Reserve (agd66) 32°15’ 46.3” S 149°11’ 18.9”E. Photographer, Jaime Plaza, 07/05/2005.

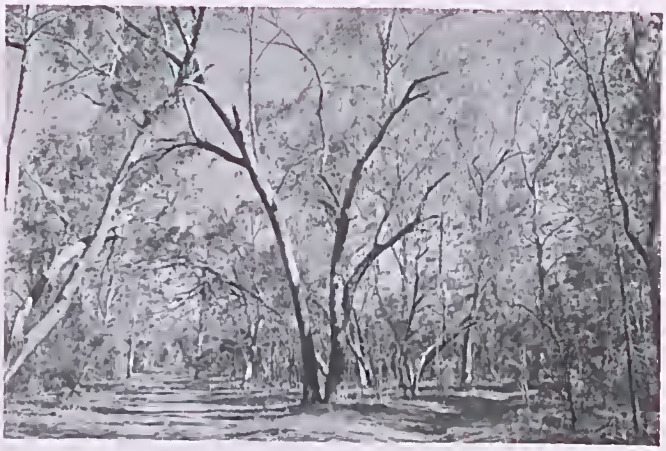

Fig. 47. D88 *Eucalyptus pilligaensis* (Pilliga Box) – *Callitris glaucophylla* shrubby woodland in Pilliga West National Park. This tall woodland is common on loam soils in the BBS Bioregion (AGD66) 30°34’ 53.8”S 148°43’ 29.5”E. Photographer, Jaime Plaza, 3/05/08.

The forests of the Pilliga Scrub

The 500 000 hectare Pilliga Scrub (Rolls 1981) between Coonabarabran in the south and Narrabri in the north represents the largest inland forest in NSW. Most of the area is composed of Pilliga Sandstone but there are small areas of acid volcanic outcrop (trachyte), alluvial soil along creeks, outwash sands, loams and clays on the northern and western edges and small areas of rich basalt soils on the forest edge in the south-east. Floristic groups in these forests were classified in RACAC (2004) based on available plot data but further survey of conservation reserves may refine this classification. The NSWVCA classification is largely based on RACAC (2004) with the addition of a few plant communities previously poorly sampled and not recognised but either recorded in vegetation reports or observed during NSWVCA field traverses (Benson 1999–2009). A history of the Pilliga forests is presented in the popular book *A Million Wild Acres* by Eric Rolls (1981). Some of Rolls’ views on forest structure and ecological processes have been questioned by Norris (1996), Norris *et al.* (1991) and Benson & Redpath (1997). A preliminary broad description of the forest vegetation communities was prepared by Binns *et al.* (1999) with a summary published in Binns & Beekers (2001). A plant species list is provided in Beckers & Binns (2000). Most of the forest was mapped (“typed”) by Lindsay (1967) using aerial photographs, vehicular and horseback traverses. While focussing on mapping canopy tree species for commercial forestry purposes, the “Lindsay Typing” nevertheless provides spatial data that could be re-interpreted (splitting or lumping of polygons) for developing a more “ecological” vegetation map of the Pilliga forests that takes into account overall floristic composition.

As a consequence of nine new community conservation (CCAZ) reserves established under the NSW Western Regional Forest Assessment concluded in 2005, there are now 12 conservation reserves in the Pilliga forests covering 242 100 hectares or nearly half of the total forest area. As of early 2010, the Pilliga forest reserves were: Dandry Gorge Aboriginal Area (AA) 382 hectares, Lane Mill Flora Reserve (FR) 731 hectares, Merriwindi CCAZ3 (State Conservation Area SCA) 1711 hectares, Pilliga CCAZ1 (National Park NP) 10 592 hectares, Pilliga CCAZ3 (SCA) 33 248 hectares, Pilliga East CCAZ2 (AA) 1344 hectares, Pilliga East CCAZ3 (SCA) 24 597 hectares, Pilliga Nature Reserve (NR) approxiamtely 83400 hectares, Pilliga West CCAZ1 (NP) 7886 hectares, Pilliga West CCAZ3 (SCA) 35 822 hectares, Timallallie CCAZ1 (NP) 39 277 hectares and Yaragin CCAZ1 (NP) 3118 hectares.

A total of 39 plant communities are recorded in the Pilliga forests in Version 3 of the NSWVCA database. Non forest communities include shrublands such as Broombush ID141, Swamp Paperbark ID410, Fringe Myrtle heath ID415 and Spur-wing Wattle ID425; mallee shrublands include Green Mallee ID256 and White Mallee ID414 and wetlands include the sedgelands ID361 and ID400 and tank gilgai ponds (ID416). These non-treed plant communities are described separately below. Approximately 30 forests or woodlands are described for the Pilliga forests. These are dominated by the tree species: *Corymbia trachyphloia* subsp. *amplistomatica* (White Bloodwood), *Eucalyptus fibrosa* (Red Ironbark), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus pilligaensis* (Pilliga Box), *Callitris glaucophylla* (White Cypress Pine), *Callitris endlicheri* (Black Cypress Pine), *Allocasuarina luehmannii* (Buloke), *Eucalyptus populnea* subsp. *bimbil* (Poplar Box) and *Eucalyptus chloroclada* (Dirty Gum).

Pilliga Box tall open forest (ID88) (Figure 47) occurs in patches throughout the Pilliga forests on loamy soils often with shrub species such as *Dodonaea viscosa* subsp. *angustifolia*, *Dodonaea viscosa* subsp. *cuneata*, *Acacia hakeoides*, *Geijera parviflora*, *Myoporum montanum* and *Acacia ixiophylla*. It is well represented in the reserve system. In the southern Pilliga forests to Coonabarabran and the Warrumbungle National Park, Inland Scribbly Gum occurs with White Bloodwood, Red Stringybark and Black Cypress Pine in a shrubby woodland on sandstone (ID379) (Figure 37). One of the most common ironbark forests in the Pilliga forests and beyond its boundaries is dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark) with White Cypress Pine, Buloke and a shrub and grass understorey (ID398) (Figure 48). It occurs on flats with sandy loam soils. A separate Narrow-leaved Ironbark forest is restricted to the western Warrumbungle Range and southern-western Pilliga (ID394). Most Narrow-leaved Ironbark forest has been extensively logged with regrowth present at various age classes. Narrow-leaved Ironbark forest sometimes grades into forests dominated by White Cypress Pine (ID396) that in some locations may be a consequence of past timber stand treatment. On the western side of the Pilliga forests, one of the most common plant communities is dominated by *Eucalyptus populnea* (Poplar Box) with White Cypress Pine, Buloke, *Atalaya hemiglauca* (Whitewood) and a range of shrub species including *Geijera parviflora*, *Acacia ixiophylla* and *Dodonaea viscosa* subsp. *spatulata* (ID397) (Figure 49). This shrubby Poplar Box woodland grades into a grassy Poplar Box woodland (ID244) on heavier soils mainly in the Darling Riverine Plains Bioregion to the west. Belah woodland (ID55), common on loam to clay soils in the NSW northern wheatbelt, occurs in small patches in the west Pilliga forests merging with Poplar Box and Pilliga Box communities. On heavier clay soils small patches of Brigalow open forest (ID35) occupies clayey soils in the northern edge of the Pilliga forests.

On sandstone outcrops mainly west of the Newell Highway, the most common shrubby open forest / woodland is dominated by *Corymbia trachyphloia* subsp. *amplistomatica* (White Bloodwood) and *Eucalyptus fibrosa* (Red Ironbark) often with Black Cypress Pine (ID405) (Figure 50). A separate Red Ironbark community occurs with *Acacia burrowii* (ID404) (Figure 51) on more sandy soil in the central to western Pilliga forests. In the eastern to south-eastern Pilliga forests a separate White Bloodwood – Broad leaved Ironbark forest occurs on rocky sandstone hills (ID406) (Figure 52) containing different shrub species from the forests in west Pilliga often with co-dominance of the low tree *Acacia cheelii* (Motherumbah). Interspersed with ID406 (including in Pilliga Nature Reserve) are small areas of *Eucalyptus nubila* (Blue-leaved Ironbark) dominated open forest (ID423). Also, in the south-eastern Pilliga forests, ID407 is dominated by Red Ironbark, White Bloodwood, Black Cypress Pine and a diverse group of shrub species. This woodland grades into Black Cypress Pine (ID417) woodland / open forest that extends south into the Garawilla region. All of the floristically similar Pilliga shrubby forest plant communities IDs 404, 405, 406, 407, 417 and 423 contain a large number of shrub species that vary in their distribution and abundance over the extent of the Pilliga forests. The forests are subjected to occasional intense wildfire. Understorey shrub composition and structure differs substantially between areas recently burnt and those unburnt for decades (compare Figure 50 to Figure 51).

Mugga Ironbark dominated tall shrubby woodland (ID402) is rare in the Pilliga forests compared to other ironbark vegetation types. Similarly, *Eucalyptus melanophloia* (Silver-leaved Ironbark) dominated woodland (ID413) or open forest is restricted in area.

A few sandstone hillcrests centred on the Pilliga Nature Reserve in the south-eastern section of the Pilliga forests contain two highly restricted types of low open forest. One is dominated by *Eucalyptus macrorhyncha* (Red Stringybark) (ID419), the other by Dwyer's Red Gum (ID424) (Figure 53) with both exhibiting a similar mid-dense to dense shrub layer growing on siliceous sandy soil. A visually striking

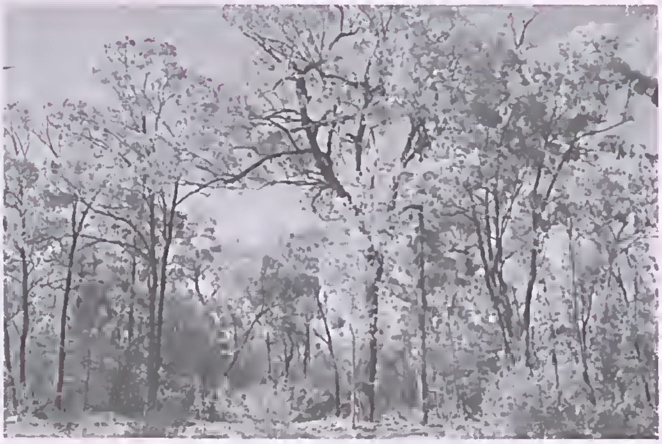

Fig. 48. ID398 *Eucalyptus crebra – Callitris glaucophylla – Allocasuarina luehmannii* tall open forest on Jacks Creek Road, Jacks Creek State Forest, Pilliga forests (AGD66) 30°26' 59.5"S 149°45' 13.4"E. Photographer, Jaime Plaza, 27/8/2008.

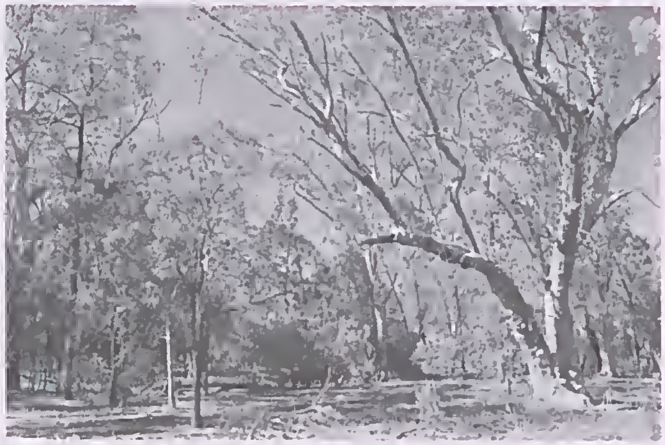

Fig. 49. ID397 *Eucalyptus populnea* subsp. *bimbil* (Poplar Box) – White Cypress Pine – *Eremophila mitchellii* (Budda) shrubby woodland, Ramp Fire Trail in Pilliga West State Conservation Area (AGD66) 30°31' 34.6"S 148°52' 48.7"E. Photographer, Jaime Plaza, 4/05/08.

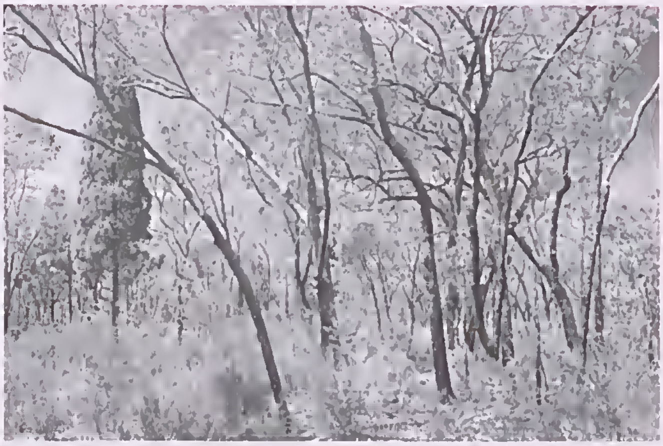

Fig. 50. ID405 *Corymbia trachyphloia – Eucalyptus fibrosa – Callitris endlicheri* shrubby woodland on a hillcrest in Galloway Fire Trail in Pilliga Nature Reserve (AGD66) 30°50' 20.8"S 149°38' 25.4"E. Photographer, Jaime Plaza, 21/3/09.

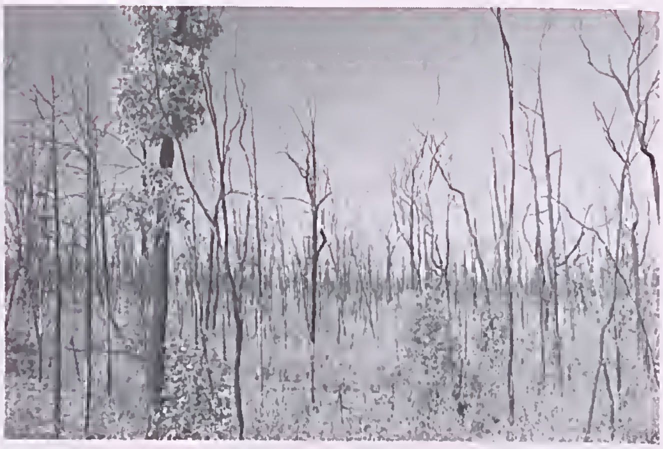

Fig. 51. ID404 Recently severely burnt (2006) *Eucalyptus fibrosa* (Red Ironbark) woodland with *Acacia burrowii* shrub regrowth, 16 foot Road, Eugigal State Forest, Pilliga forests (AGD66) 30°45' 47"S 149°10' 20.9"E. Photographer, Jaime Plaza, 7/05/08.

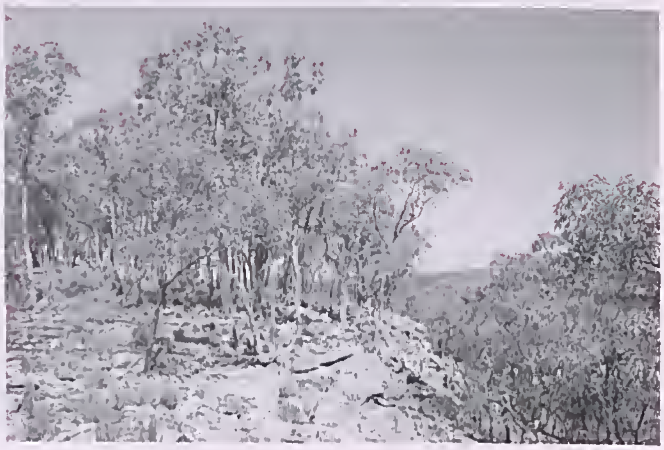

Fig. 52. ID406 *Corymbia trachyphloia* subsp. *amphistomatica* (White Bloodwood) – *Eucalyptus fibrosa* (Red Ironbark) – *Acacia cheelii* woodland on a sandstone ridge outcrop, Scratch Road, Pilliga East State Forest (AGD66) 30°36' 28"S 149°50' 59.3"E. Photographer, Jaime Plaza, 27/8/2008.

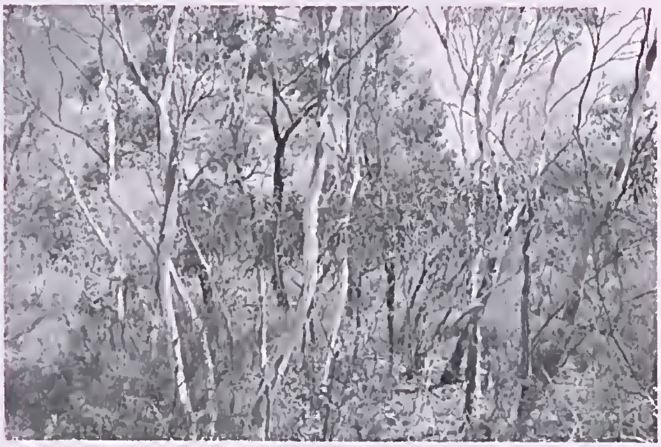

Fig. 53. ID424 *Eucalyptus dwyeri – Eucalyptus crebra* dense heath low open woodland on a flat sandstone ridge in Pilliga Nature Reserve (AGD66) 30°51' 38.5"S 149°36' 17.3"E. Photographer, Jaime Plaza, 21/3/09.

plant community in the north-eastern Pilliga forests is a tall open forest dominated by *Angophora leiocarpa* (Smooth-barked Apple) with White Bloodwood, Narrow-leaved ironbark and both Black and White Cypress Pine and a heath shrub understorey containing species such as *Brachyloma daphnoides* subsp. *pubescens*, *Xanthorrhoea johnsonii*, *Persoonia sericea*, *Bossiaea rhombifolia* subsp. *rhombifolia* and *Jacksonia scoparia* (ID422) Figure 54). This open forest extends north towards Warialda and is allied to a more northern NSW Smooth-barked Apple tall forest in the sandstone forests around Yetman (ID368) that contains some different shrub and tree species.

The most common red gum species in the Pilliga forests is *Eucalyptus chloroclada* (Dirty or Baradine Gum) which is a dominant tree in three forest communities. ID399 (Figure 55) is a riparian red gum – *Leptospermum polygalifolium* subsp. *transmontanum* (tea tree) woodland on the banks of sandy streams throughout the Pilliga where other red gums *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus blakelyi* (Blakely's Red Gum) intergrade with it. River Red Gum is restricted to the larger perennial streams such as the lower Baradine Creek. Dirty Gum also occurs in *Angophora floribunda* (Rough-barked Apple) dominated open forest with White Cypress Pine on sandy alluvial or colluvial flats and lower slopes (ID401). On higher slopes Dirty Gum co-dominates open forests or woodlands with White Cypress Pine and White Bloodwood on sandy soils (ID409) and on shallow soils on sandstone Black Cypress Pine and White Bloodwood (ID408) (Figure 56).

Allocasuarina luehmannii (Buloke) woodland (ID411) (Figure 57) is mainly restricted to outwash, sodic soil in the north-western Pilliga forests grading into *Melaleuca densispicata* tall shrubland (ID410) where the water table is close to the land surface. It also grades into "tank gilgai" wetland (ID416) on clay soils. Buloke occurs with *Eucalyptus chloroclada* (Dirty Gum) on deep sand lenses (Sand Monkeys) in the west Pilliga region (ID206) and a similar forest occurs on the edge of the Trinkey State Conservation Area on the western edge of the Liverpool Plains (ID148) south-east of the Pilliga forests.

Several woodland types occur on higher nutrient alluvial or basaltic soils in the Pilliga Scrub. Small areas of Yellow Box – White Cypress Pine grassy woodland (ID421) (Figure 58) occurs on alluvial terraces adjacent to major steams grading into small areas of Fuzzy Box woodland (ID202). *Eucalyptus albens* (White Box) shrubby woodland occurs on higher nutrient soils on the edge of the Pilliga forests including ID412 in the eastern Pilliga forests, including on basalt, extending south into the Garawilla region east of Coonabarabran. The other shrubby White Box woodland, ID393, occurs in the extreme south-western Pilliga forests extending south into Warrumbungle National Park and the surrounding region. A small area of dry rainforest dominated by *Ficus rubiginosa* (Rusty Fig), *Alphitonia excelsa* (Red Ash) and *Notelaea microcarpa* (Mock Olive) (ID388) (Figure 59) occurs on protected sandstone hills in and on the edge of Pilliga East Aboriginal Area. Fire history may be a determinant of this rare community.

Sandstone forests between Narrabri and Yetman

White Cypress Pine, Buloke, Narrow-leaved Ironbark, Smooth-barked Apple, *Corymbia dolichocarpa* (Large-fruited Bloodwood), *Corymbia tesselaris* (Carbeen), *Corymbia trachyphloia* (White Bloodwood), Dirty Gum and Stringybark She Oak are the main tree species comprising the canopy of open forests on sandstone outcrops or deep sandy soils between Narrabri and the Queensland border in the BBS Bioregion. Most of these open forests have a shrubby understorey with the species composition gradually changing from south to north. White Cypress Pine is omnipresent across these landscapes with some previous or current State Forests being subject to forestry practices that favour it over eucalypt species, a good example being in the previous Mission State Forest (now part of Terry Hie Hie Aboriginal Area).

Tall open forest dominated by White Cypress Pine and Silver-leaved Ironbark with *Geijera parviflora* (Wilga) shrub layer is widespread between Narrabri and Yetman with the largest areas near Terry Hie Hie, east of Moree (ID418) (Figure 60). This forest grades into shrubby Poplar Box woodland on loamy soils (ID397) near Narrabri. *Eucalyptus fibrosa* (Red Ironbark) open forest is relatively rare north of Narrabri compared to its abundance in the Pilliga Scrub and Goonoo forest to the south. Small areas occur on rocky hills between Warialda and Yetman where *Eucalyptus fibrosa* occurs with *Allocasuarina inophloia* (Stringybark She Oak) (ID443).

Corymbia tesselaris (Carbeen) woodland often occurring with White Cypress Pine and River Red Gum occurs on sandy rises adjacent to rivers in the northern-most parts of BBS, NAN and Darling Riverine Plains Bioregions (ID71). To the south, small areas of Carbeen – White Cypress Pine – *Acacia leiocalyx* (Curracabah) – White Box tall woodland are scattered on sandy soil in the forests between Narrabri and Warialda (ID428).

Dthinna Dthinnawan National Park (formally Bebo State Forest) is situated on sandstone hills near Yetman. It contains a number of distinct plant communities. One of the most structurally distinctive woodlands in the BBS Bioregion occurs on sodic (highly alkaline) outwash sandy soils on the western side of Dthinnia Dthinnawan National Park that contains a tree canopy of Buloke and a dwarf form of *Eucalyptus microcarpa* (Inland Grey Box) with a ground cover dominated by the hummock grass *Triodia scariosa* subsp. *yelarbonensis* (ID235) (Figure 61). This low woodland grades into *Melaleuca densispicata* shrubland (ID363) on scalded clays and into Yetman sodic wetlands (ID364) where the water table reaches the ground surface. On the eastern edge of Dthinna Dthinnawan National Park *Eucalyptus blakelyi* <-> *tereticornis* intergrade (Blakely's Red Gum

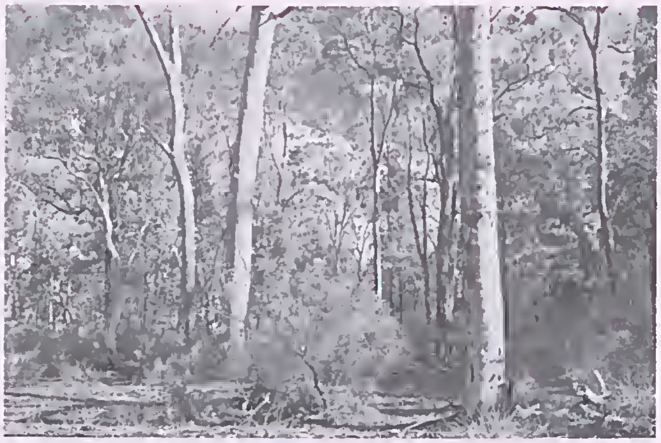

Fig. 54. ID422 *Angophora leiocarpa* (Smooth-barked Apple) – *Corymbia trachyphloia – Callitris endlicheri* shrubby woodland on Delwood Road in Pilliga East State Conservation Area (AGD66) 30°48' 0.6"S 149°37' 24.5"E. Photographer, Jaime Plaza 26/8/2008.

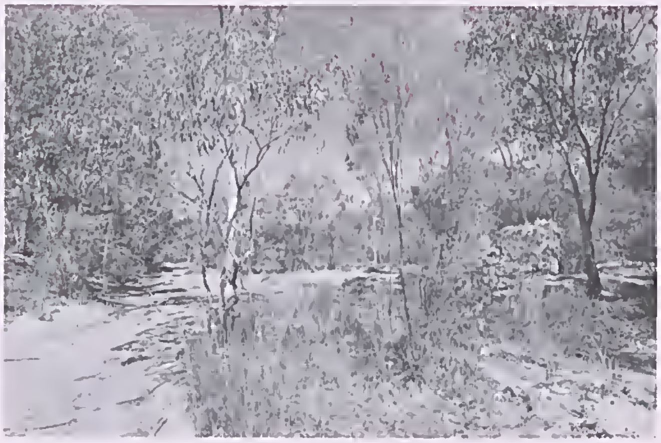

Fig. 55. ID399 *Eucalyptus camaldulensis* x *Eucalyptus blakelyi* (red gum) woodland with *Leptospermum polygalifolium* in a sandy creek in the Pilliga forests (AGD66) 30°27' 56.3"S 149°3' 1.4"E. Photographer, Jaime Plaza, 5/05/08.

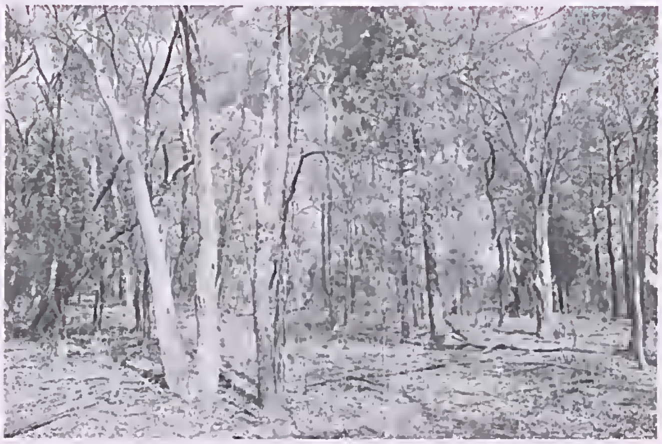

Fig. 56. ID408 *Eucalyptus chloroclada* (Dirty Gum) – *Callitris endlicheri* (Black Cypress Pine woodland on sandstone rise in Bullawa Creek CCAZ3, north of Narrabri (AGD66) 30°20' 23.9"S 149°53' 30.7"E. Photographer, Jaime Plaza, 21/8/2008.

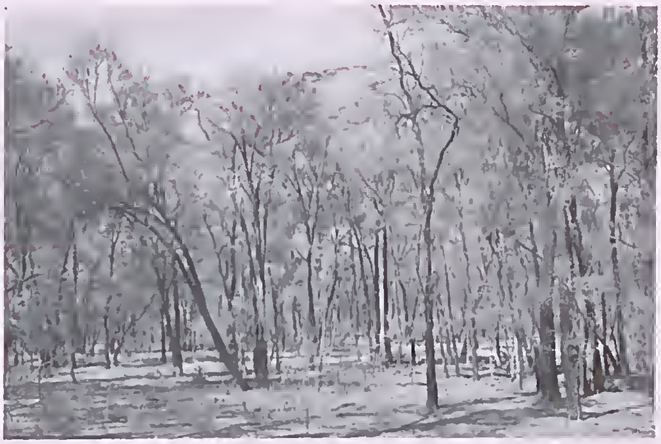

Fig. 57. ID411 *Allocasuarina luehmannii* (Buloke) woodland on sodic soils in Pilliga National Park in the north-western Pilliga forests with a *Cladia retipora* lichen crust (AGD66) 30°30' 2.5"S 149°21' 21.3"E. Photographer, Jaime Plaza, 25/8/08.

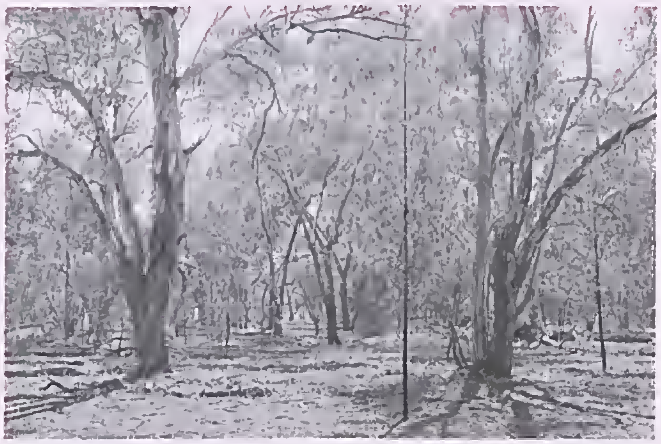

Fig. 58. ID421 *Eucalyptus melliodora – Callitris glaucophylla* woodland on a terrace flat above Borah Creek in Pilliga Nature Reserve (AGD66) 30°51' 51.1"S 149°31' 10.9"E. Photographer, Jaime Plaza, 21/3/2009.

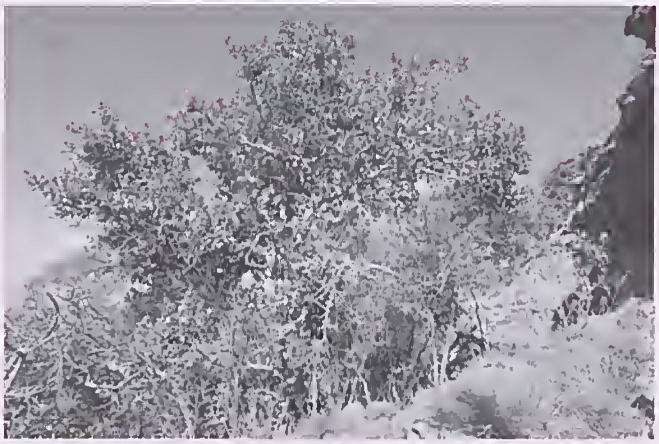

Fig. 59. ID388 *Alphitona excelsa – Ficus rubiginosa – Notelaea microcarpa* dry rainforest on the slopes of Willala Mountain, eastern Pilliga forests (AGD66) 30°49' 59.2"S, 149°45' 49.7"E. Photographer, Jaime Plaza, 21/3/2009.

x Forest Red Gum) occurs with *Eucalyptus moluccana* (Coastal Grey Box) and *Angophora floribunda* in a shrub grass woodland (ID367) (Figure 62) on loam to clay soil. This woodland extends into the Park along watercourses and in depressions with the red gum having been misidentified as River Red Gum in past botanical surveys. It is one of a few locations in NSW where Forest Red Gum occurs west of the Great Dividing Range. The woodland is somewhat similar to east coast valley woodlands containing the same mix of tree species, especially those in south east Queensland. An associated Grey Box woodland (ID374) also occurs in this area. Dthinna Dthinnawan National Park also contains floristically distinct and highly restricted swampy woodland on white sand dominated by *Eucalyptus blakelyi* (ID369) (Figure 63). This is probably the most restricted eucalypt-dominated woodland plant community in the NSW North-western Slopes with a known extent of 35 hectares. It occurs on white sand lenses with an impervious subsoil layer that maintains a high water table. The Proteaceous small tree / tall shrub *Xylomelum cunninghamianum* (Woody Pear) is conspicuous and other shrub species include *Leptospermum polygalifolium* subsp. *transmontanum, Gompholobium virgatum* var. *aspalathoides, Calytrix longiflora* and *Conospermum taxifolium.* Ground species include the endangered fern *Platyzoma microphyllum* along with *Schoenus ericetorum, Pomax umbellata, Brachyscome diversifolia* var. *dissecta.* More common plant communities in Dthinna Dthinnawan National Park and surrounding regions include ID371 dominated by Silver-leaved Ironbark and Stringybark She Oak; ID373 (Figure 64), a tall open forest dominated by Narrow-leaved Ironbark, White Cypress Pine and Buloke tall open forests and on higher hillcrests; ID370, containing Black Cypress Pine with Dirty Gum, Large-fruited and White Bloodwood and Stringybark She Oak. Small areas of *Acacia* (Wattle)-dominated low forest occur on hillcrests including species such as *Acacia sparsiflora, Acacia crassa* and *Acacia burrowii* (ID372).

One of the most common shrubby forests on sandstone and sandy soils between Warialda and Yetman is dominated by White Bloodwood, Dirty Gum with either White or Black Cypress Pine and a shrubby understorey (ID431). Another common forest type is dominated by *Angophora leiocarpa* (Smooth-barked Apple) forming a tall open forest with White and Black Cypress Pine, Long-fruited Bloodwood and Dirty Gum (ID368). A poorly defined grassy Smooth-barked Apple forest occurs on sandy flats west of Warialda (ID450) and an open forest with Smooth-barked Apple – Red Stringybark – Black Cypress Pine open forest occurs near Warialda, including in Arakoola Nature Reserve (ID448) (Figure 65). These Smooth-barked Apple communities merge with the southern type (ID422) that extends north from the Pilliga Scrub to the Warialda district.

The sandstone forests grade into grassy woodlands on alluvial loam to clay soils such as Silver-leaved Ironbark – White Cypress Pine – Rough-barked Apple woodland on alluvial terraces (ID237) from near the Pilliga forests to Yetman.

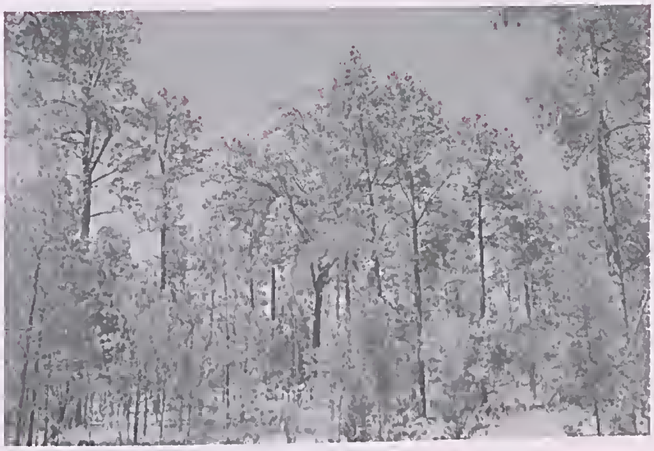

Fig. 60. ID418 *Callitris glaucophylla* (White Cypress Pine) tall woodland in Terry Hie Hie Aboriginal Area (agd66) 29°45'18.78"S 150°9'37.38"E. Photographer, Jaime Plaza, 21/11/2007.

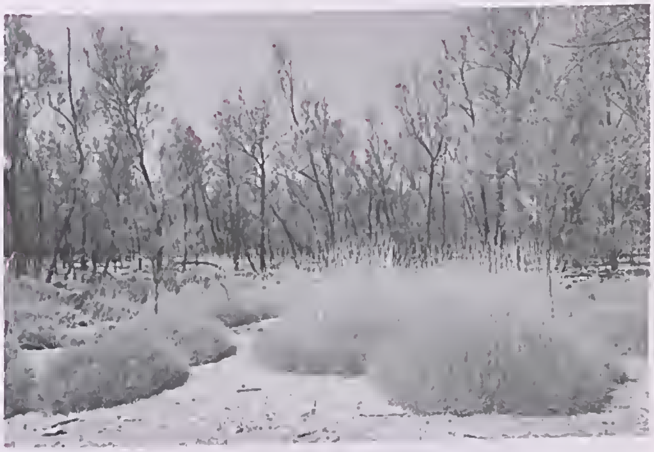

Fig. 61. ID235 *Tridodia scariosa* subsp. *yelarbonensis* (spinifex) with *Allocasuarina leuhmannii* (Buloke) and *Eucalyptus microcarpa* (Western Grey Box) on sandy soil over sodic subsoil between Yetman and Yelarbon (agd66) 28°47' 48.8S 150°43' 26.6"E. Photographer, Jaime Plaza, 14/11/07.

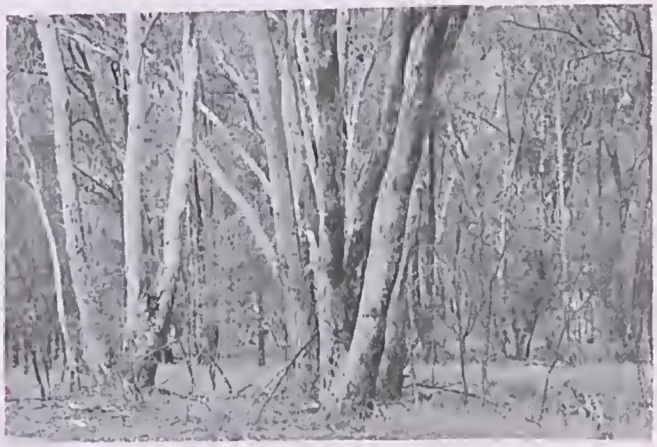

Fig. 62. ID367 *Eucalyptus blakelyi* x *tereticornis* with *Eucalyptus moluccana* shrub grass woodland on a valley flat on Bebo Road north-east of Yetman (agd66) 28°52'54.3"S, 150°54'30.36"E. Photographer, Jaime Plaza, 15/11/2007.

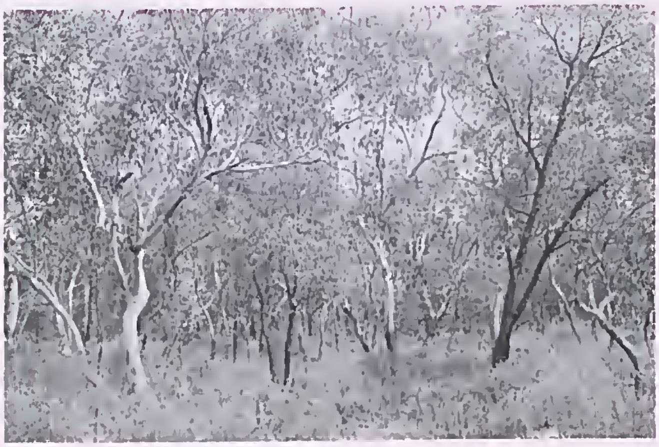

Fig. 63. ID369 *Eucalyptus blakelyi – Xylomelum cunninghamianum* (Woody Pear) shrub swamp woodland with the endangered fern *Platyzoma microphyllum* on siliceous white sand in Dthinna Dthinnawan National Park near Yetman (agd66) 28°51' 12.6"S, 150°49' 37.2"E. Photographer, Jaime Plaza, 15/11/2007.

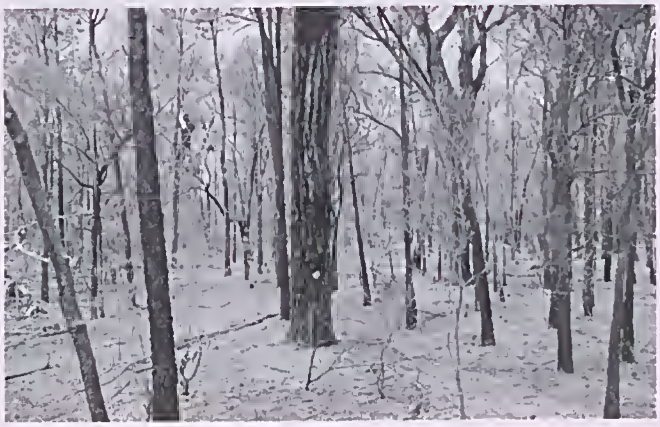

Fig. 64. ID373 *Eucalyoptus crebra – Allocasuarina luehmannii – Allocasuarina inophloia* open forest in Dthinna Dthinnawan National Park near Yetman (agd66) 28°48'3.42"S 150°54'9.78"E. Photographer, Jaime Plaza, 15/11/2007.

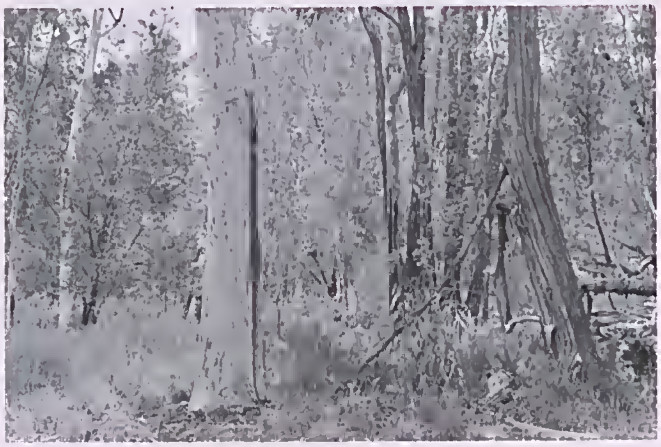

Fig. 65. ID448 *Angophora leiocarpa* (Smooth-barked Apple) – *Eucalyptus macrorhyncha* (Red Stringybark) shrubby open forest on sandstone hills in Arakoola Nature Reserve (agd66) 29°17'23.64"S 150°47'51.72"E. Photographer, Jaime Plaza, 18/11/2007.

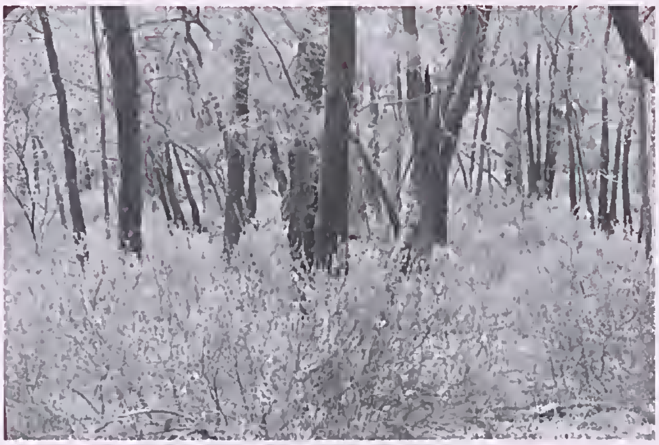

Fig. 66. ID449 *Allocasuarina inophloia – Eucalyptus crebra* low woodland with *Prostanthera cryptandroides* subsp. *eupharasioides* and the grass *Cleistochloa rigida* in Strathmore State Forest (agd66) 29°23'31.08"S 150°23'35.76"E. Photographer, Jaime Plaza, 19/11/2007.

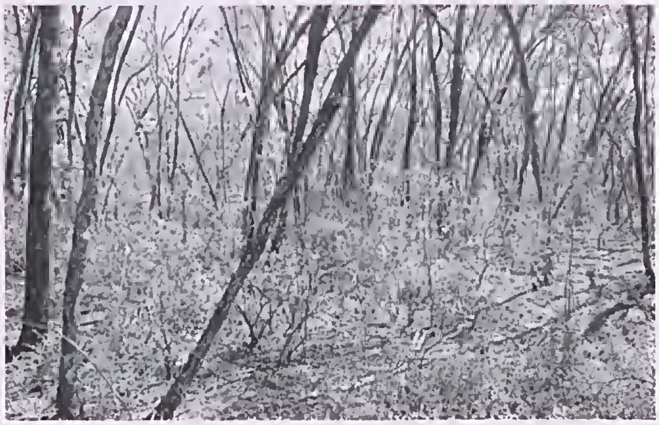

Fig. 67. ID179 *Eucalyptus viridis* (Green Mallee) mallee forest with shrubby understorey on a stony hill in Burra Yurril Aboriginal Area, south of Yetman (agd66) 29°5'25.86"S 150°48'26.94"E. Photographer, Jaime Plaza, 16/11/2007.

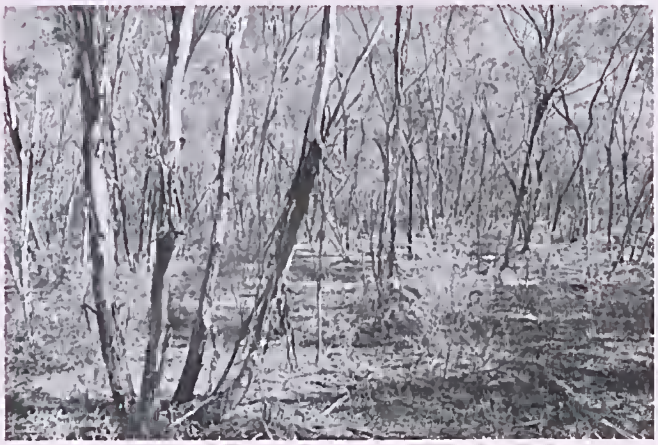

Fig. 68. ID256 *Eucalyptus viridis* (Green Mallee) mallee woodland on Ironbark Crossing Road in Pilliga State Conservation Area (AGD66) 30°36' 43"S 149°11' 35.1"E. Photographer, Jaime Plaza, 24/3/08.

A feature of shallow sandstone and acid volcanic soils in the northern BBS and NAN Bioregions is the prevalence of the small tree *Allocasuarina inophloia* (Stringybark She Oak) as a canopy or sub-canopy tree. It occurs with Silver-leaved Ironbark in ID371 and is common in Narrow-leaved Ironbark forest (ID373) on sandstone hills near Yetman. An unusual and restricted plant community in which Stringybark She Oak is a dominant tree is Stringybark She Oak – Narrow-leaved Ironbark – sticky mintbush low woodland (ID449) (Figure 66) that occurs on sandstone rises north-west of Warialda including in Strathmore State Forest and in Bullala National Park. Its understorey is dominated by *Prostanthera cryptandroides* subsp. *euphrasioides* (Sticky Mintbush), *Acacia conferta, Pimelea linifolia* subsp. *collina* and *Acacia amblygona.* In the NAN Bioregion to the east, Stringybark She Oak occurs on acid volcanic substrate with *Eucalyptus andrewsii, Eucalyptus crebra, Eucalyptus dealbata* and *Callitris endlicheri* (IDs 505, 584, 600).

Mallee, Broombush and other myrtaceous shrublands on sandstone and sand

The most common mallee vegetation is dominated by *Eucalyptus viridis* (Green Mallee) that often grows on iron-rich sandstone rises or low hills. There are two communities of Green Mallee. ID179 (Figure 67) occurs in the BBS and Nandewar Bioregions north from Narrabri to near Warialda, often with White Cypress Pine, *Alphitonia excelsa* (Red Ash) and typically viney scrub species such as *Carissa ovata*. The other Green Mallee community, ID256 (Figure 68), occurs from Dubbo to the Pilliga forests. It typically contains shrub species such as *Dodonaea viscosa* subsp. *cuneata, Melichrus urceolatus, Cassinia arcuata* and *Acacia hakeoides.* Neither of these Green Mallee types is threatened although they are restricted in extent. A more threatened and rarer mallee type is ID414 dominated by *Eucalyptus dumosa* (White Mallee) with *Eucalyptus dwyeri, Callitris endlicheri* and often *Eucalyptus fibrosa.* This occurs in small stands on sandy soils near Coolbaggie Nature Reserve north of Dubbo and in the Pilliga forests further north. A highly restricted mallee heath occurs on an aeolian sandplain near Gilgandra being dominated by *Eucalyptus dwyeri* with shrubs including the she oak *Allocasuarina diminuta* subsp. *diminuta, Grevillea arenaria* subsp. *canescens, Calytrix tetragona* and *Leptospermum divaricatum* (ID474).

The most common shrubland in the Pilliga Scrub and Goonoo sandstone regions of the BBS Bioregion is dominated by *Melaleuca uncinata* (Broombush) often with *Acacia burrowii* (Burrow's Wattle) forming a tall shrubland (ID141) (Figure 69). This occurs on deep sandy soils over sandstone substrate and includes a rich diversity of shrub species including *Melaleuca uncinata, Acacia burrowii, Westringia cheelii, Calytrix tetragona, Acacia triptera, Melaleuca diosmatifolia, Cryptandra amara* var. *amara, Acacia tindaleae, Acacia caroleae, Acacia mariae, Micromyrtus sessilis, Allocasuarina diminuta* subsp. *diminuta* and *Mirbelia pungens.* A few

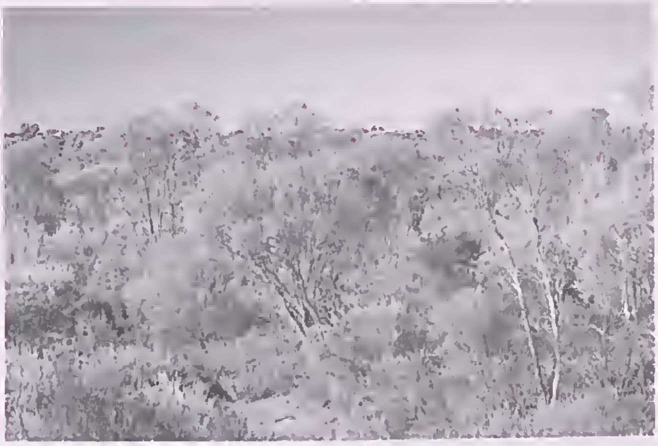

Fig. 69. ID141 *Melaleuca uncinata* (Broombush) – *Calytrix tetragona – Acacia mariae* tall shrubland, Ironbark Crossing Road, Pilliga State Conservation Area (AGD66) 30°38' 29.2"S 149°11' 0.7"E. Photographer, Jaime Plaza, 24/08/2008.

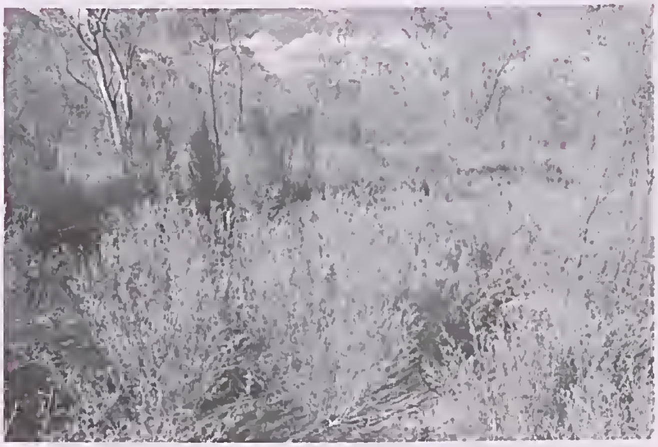

Fig. 70. ID366 Heathland dominated by *Calytrix tetragona* (Fringe Myrtle) on sandstone rock flats in Dthinna Dthinnawan National Park near Yetman (agd66) 28°46'59.34"S 150°51'24.54"E. Photographer, Jaime Plaza, 14/11/2008.

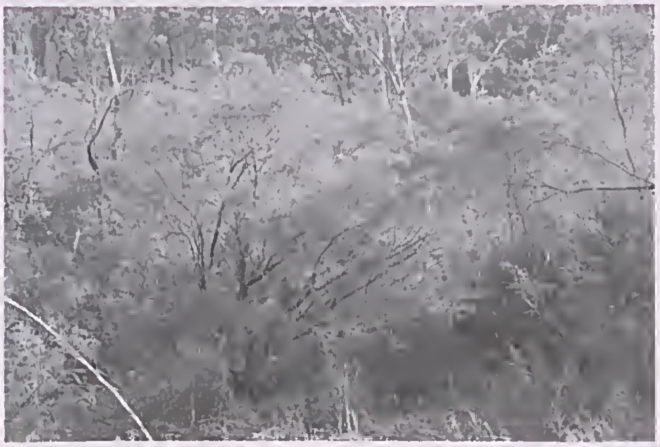

Fig. 71. ID612 *Leptospermum parvifolium – Leptospermum polygalifolium* (teatree) shrubland on rocky slope on Narrabeen Sandstone near Towarri National park north of Scone (AGD66) 31°53'6.8"S 150°47'57"E. Photogrpaher, Jaime Plaza, 10/5/09.

shrublands are dominated by *Calytrix tetragona* (Fringe Myrtle). Small patches of dense shrubland dominated by *Acacia triptera* (Spur-wing Wattle) and *Calytrix tetragona* with *Harmogia densifolia* (ID425) occur in the Pilliga and Goonoo forests. In the far north of the BBS Bioregion, a shrubland dominated by *Calytrix tetragona*, *Harmogia densifolia* and *Hibbertia crinita* is restricted to sandstone rock flats mostly in Dthinna Dthinnawan National Park near Yetman (ID366) (Figure 70) while in the north-western Pilliga Scrub forests *Calytrix tetragona*, *Acacia spectabilis* and *Brachyloma daphnoides* subsp. *daphnoides* dominate a shrubland in small forest openings on sandy loam soil (ID415).

In the Mendooran region in the southern part of the BBS Bioregion small patches of shrubland dominated by *Melaleuca thymifolia* (Thyme Honey-myrtle), *Pultenaea microphylla* and *Leucopogon biflorus* occur on sandy watercourses overtopped with Blakely's Red Gum (*Eucalyptus blakelyi*) or ironbark such as *Eucalyptus sideroxylon* (ID472). A tea tree (*Leptospermum parvifolium* and *Leptospermum polygalifolium* subsp. *transmontanum*) dominated tall shrubland (ID612) (Figure 71) occurs on Triassic sandstone outcrops along creeks on the southern lower slopes flanks of the Liverpool Range including in Towarri National Park north of Scone. This is compositionally similar to Sydney Basin Bioregion tea tree riparian shrublands.

Shrublands in the Warrumbungle, Mount Kaputar and on the Liverpool Ranges

On high hillcrests in Warrumbungle National Park, such as along the Grand High Tops walking trail, small areas of very tall *Acacia doratoxylon* (Currawang) shrubland (ID390) grows on trachyte ridges (Figure 72). Associate species include Tumbledown Gum and the shrub *Beyeria viscosa*. On the rocky summits of trachyte peaks in the Warrumbungle Range, a distinct shrubland (ID391) (Figure 73) contains shrub species including *Phebalium squamulosum* subsp. *coriaceum*, *Acrotriche rigida*, *Ozothamnus obcordatus* subsp. *major*, *Leionema viridiflorum* and *Calytrix tetragona*. A variation of ID391 is dominated by the she oak *Allocasuarina gymnanthera* along with *Ozothamnus obcordatus* subsp. *obcordatus*, *Micromyrtus sessilis*, *Acacia cultriformis* and *Melichrus erubescens* (ID392). This occurs on the top of Bluff Mountain and perhaps a few other peaks.

A common shrubland on high trachyte peaks and rock shelves on the Mount Kaputar volcanic massif contains mallee forms of *Eucalyptus dwyeri* (Dwyer's Red gum) and *Eucalyptus nandewarica* (Nandewar Mallee) with a heath understorey including *Kunzea* sp. 'Mount Kaputar', *Ozothamnus obcordatus* subsp. *major*, *Calytrix tetragona*, *Acacia triptera* and *Olearia ramulosa* (ID521, Figure 74). A variant on this shrubland occurs on rock outcrops in the Dripping Rock region to the south-east of Mount Kaputar (ID520).

On the Liverpool Range, a structurally and floristically distinct plant community is ID611 (Figure 75): "Grass Tree

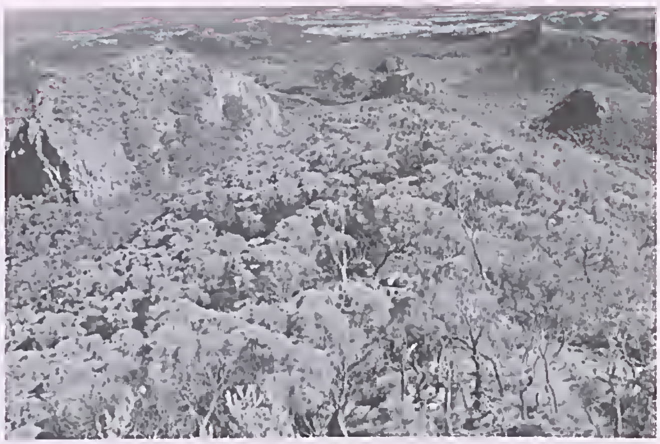

Fig. 72. ID390 *Acacia doratoxylon* tall shrubland on ridge running north of Bluff Mountain in Warrumbungle National Park (AGD66) 31°20' 57.6"S, 148°58' 40.2"E. Photographer, Jaime Plaza, 16/09/06.

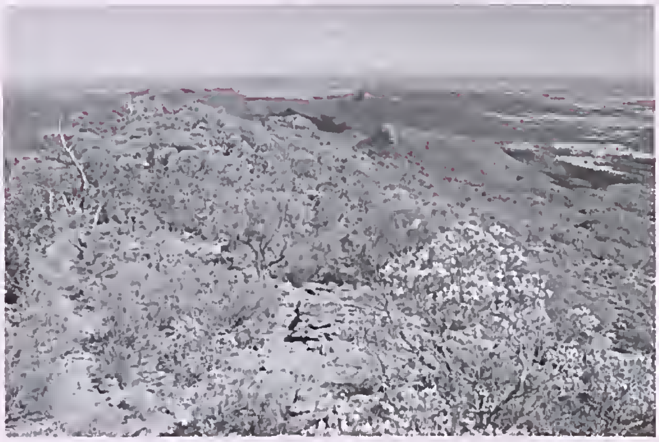

Fig. 73. ID391 Heathland with *Phebalium squamulosum* subsp. *coriaceum* on top of Bluff Mountain in Warrumbungle National Park (AGD66) 31°20' 57.6"S 148°58' 40.2"E. Photographer, Jaime Plaza, 16/09/06.

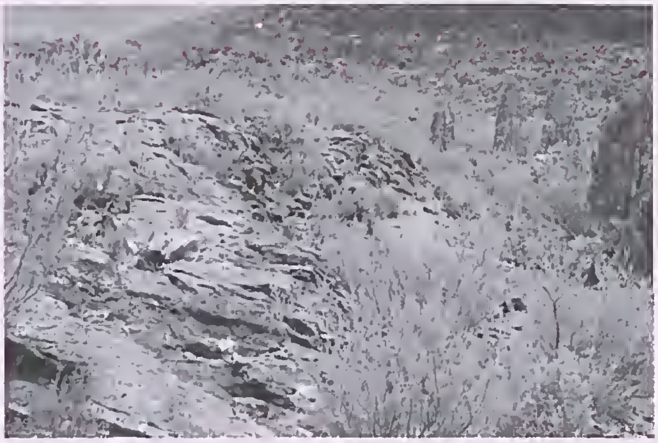

Fig. 74. ID521 Heathy shrublands on trachyte outcrops in the Mount Kaputar area, Mount Kaputar NP (GDA94) 30°16' 02"S 150°03' 12"E. Photographer, P. Richards, 11/12/2007.

tall shrubland on shallow basalt soil and talus on the Liverpool Range". This tall open shrubland is dominated by the grass tree *Xanthorrhoea glauca* subsp. *glauca* and is restricted to basalt rock-scree. A similar grass tree community occurs on serpentinite near Bingara. Another restricted shrubland that also occurs on basalt hillslope and scree on the Liverpool Range is dominated by *Melicytus dentatus* (Tree Violet) and the cough bush *Cassinia uncata* (ID499).

Shrublands in the New England / Nandewar bioregions on granite and acid volcanic substrates

A number of shrublands occur on rhyolite and granite outcrops in the west New England and Nandewar Bioregions including in the vicinity of Tingha, Kings Plains, Severn River, Mole Creek and Tenterfield. On the western New England Tableland a heathy shrubland / woodland with White Cypress Pine, *Eucalyptus prava* (Orange Gum) and *Acacia* spp. occurs on granite outcrop in the Moonbi region north of Tamworth (ID555). A more widespread shrubland in the north-western New England Bioregion, including near Bendemeer and the upper Severn River, contains Black Cypress Pine and Orange Gum with a heath understorey (ID503). A threatened shrubland colloquially known as the Howell shrubland (ID519) (Figure 76) occurs near Copeton Dam and Inverell in the NAN Bioregion. It contains shrub species such as *Homoranthus prolixus, Babingtonia densifolia, Acacia triptera* and *Leucopogon neoanglicus*. A restricted shrubland / woodland on Bolivia Hill in the northern part of the New England Bioregion (ID548) contains an unusual assemblage of species such as the trees *Acacia pycnostachya, Callitris endlicheri, Eucalyptus prava, Eucalyptus dealbata, Eucalyptus banksii* and *Eucalyptus boliviana* and the shrubs *Leucopogon neoanglicus, Micromyrtus sessilis, Kunzea bracteolata* and *Leptospermum arachnoides*. Shrublands are widespread on acid volcanic outcrops in the Severn River and Kings Plains regions including the widely distributed ID561 with over-topping trees of Black Cypress Pine, Orange Gum and *Eucalyptus caleyi* subsp. *caleyi* and containing shrub species such as *Calytrix tetragona, Leucopogon neoanglicus* and *Allocasuarina brachystachya*. A more restricted shrubland occurs on rhyolite peaks near Pindari Dam dominated by low trees of *Allocasuarina inophloia* (Stringybark She Oak), Black Cypress Pine, *Eucalyptus dwyeri* (Dwyer's Red Gum) with shrubs such as *Calytrix tetragona, Melichrus urceolatus, Leptospermum brevipes, Cassinia laevis* and *Leucopogon melaleucoides* (ID600). A larger variety of shrublands occur on granite substrates in the eastern half of the New England Tableland Bioregion but they are not covered in this version of the NSWVCA.

Acacia-dominated shrublands and woodlands

Remnants of a previously widespread *Acacia pendula* (Weeping Myall) low woodland (ID27) occur on alluvial clay soil on the Liverpool Plains and on the western edge of the BBS Bioregion. Small patches of *Acacia stenophylla* (River Cooba) tall shrubland (ID214) occur on inland floodplains. Various Acacia-dominated shrublands occur on sandstone including ID372 that contains *Acacia sparsiflora, Acacia crassa, Alphitonia excelsa, Acacia burrowii and Allocasuarina inophloia* near Yetman. An *Acacia cheelii* (Motherumbah) – red gum – White Cypress Pine woodland occurs in the Warialda to Yetman region (ID430) (Figure 77). In the Warrumbungle-Coonabarabran region in the southern part of the BBS Bioregion, ID389 is dominated by *Acacia cheelii* (Motherumbah), *Corymbia trachyphloia* subsp. *amphistomatica* (White Bloodwood) and Black Cypress Pine. *Acacia doratoxylon* (Currawang) tall shrubland is rarer on the NSW north-western slopes compared to NSW south western slopes. Small patches occur on sandstone and trachyte hillcrests on the Warrumbungle Range (ID390)

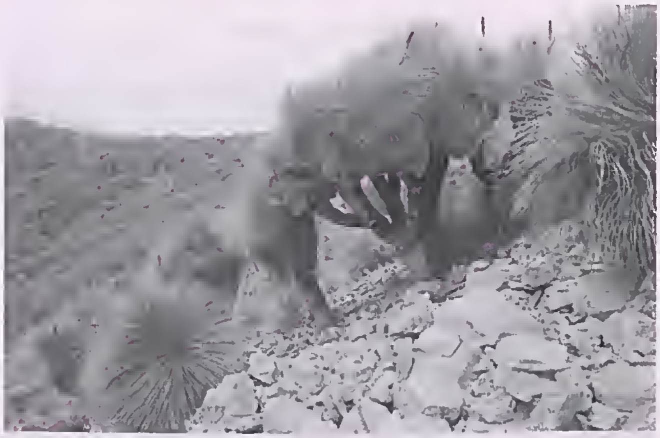

Fig. 75. ID611 *Xanthrorhoea glauca* subsp. *glauca* tall grasstree open shrubland on a basalt rock scree on Heavens Ridge Fire Trail in the northern part of Towarri National Park (AMG66) 31°51'51.9"S 150°46'5.9"E. Photographer, Jaime Plaza, 10/5/09.

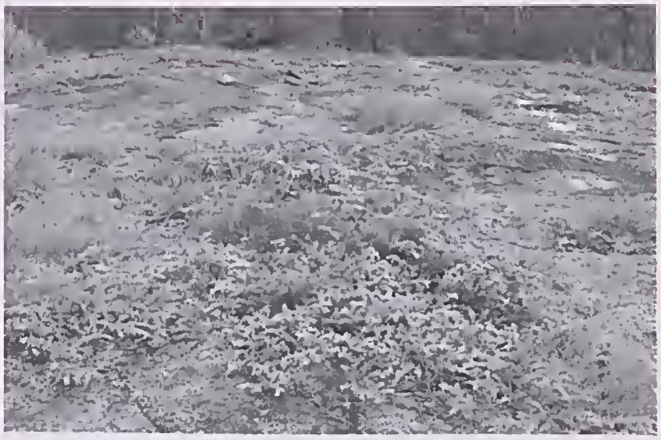

Fig. 76. ID519 Heathy shrubland with *Homoranthus prolixus* in the Howell area of the New England Tablelands, Goonoowigal State Conservation Area (GDA94) 29°48' 55"S 151°07' 05"E, Photographer, P. Richards, 26/10/2007.

(Figure 72). At the southern edge of the BBS Bioregion crossing into the Sydney Basin Bioregion, small areas of *Acacia linearifolia* woodland (ID476) (Figure 78) occur on sandstone rises in ironbark-dominated open forests. *Acacia homalophylla* (Yarran) – dominated tall shrubland (ID77) occurs in small patches throughout the BBS Bioregion, including on the Liverpool Plains.

Riparian shrublands and forblands

In the southern part of the BBS Bioregion stream banks are often dominated by a *Callistemon sieberi* (Bottlebrush) shrubland (ID333) (Figure 79), a community that extends into the NSW South Western Slopes Bioregion. A common riparian shrubland at high elevations on the Warrumbungle Range and western Liverpool Range is dominated by tea tree species such as *Leptospermum gregarium* or *Leptospermum polygalifolium* subsp. *transmontanum* with the forbs *Hydrocotyle tripartita, Hydrocotyle peduncularis* (Pennyroyal), *Gratiola peruviana* and the rush *Juncus vaginatus* in the ground cover (ID446). In creeks and drainage areas in the NAN and west New England Bioregion a shrubland dominated by *Leptospermum polygalifolium* subsp. *transmontanum* (tea tree), *Pultenaea setulosa* and *Hakea microcarpa* occupies various substrates including acid volcanic and granite (ID574) (Figure 80).

Native grasslands

Native grasslands are a feature of this region compared to most other parts of NSW. In the extreme west *Astrebla* (Mitchell Grass)-dominated low chenopod shrub grassland occurs on alluvial soils (ID43) mainly in the DRP Bioregion grading into similar grassland occurring on deep black earth and clay soils around Moree to the east (ID52) that is dominated by *Dichanthium sericeum* subsp. *sericeum*

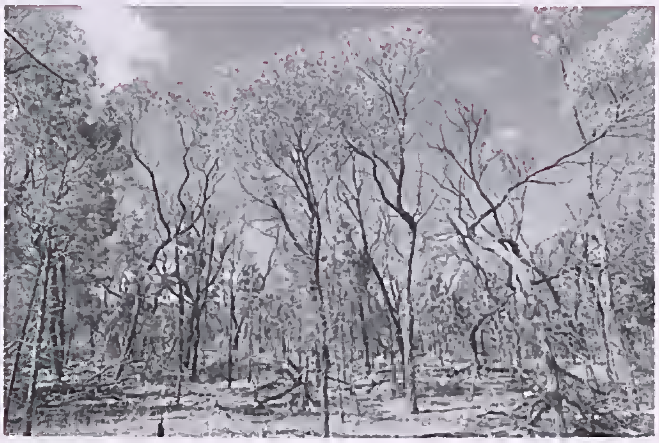

Fig. 77. ID430 *Acacia cheelii – Eucalyptus dwyeri* woodland in Couradda National Park (AGD66) 30°5' 2.6"S 149°55' 58"E. Photographer, Jaime Plaza, 23/8/2008.

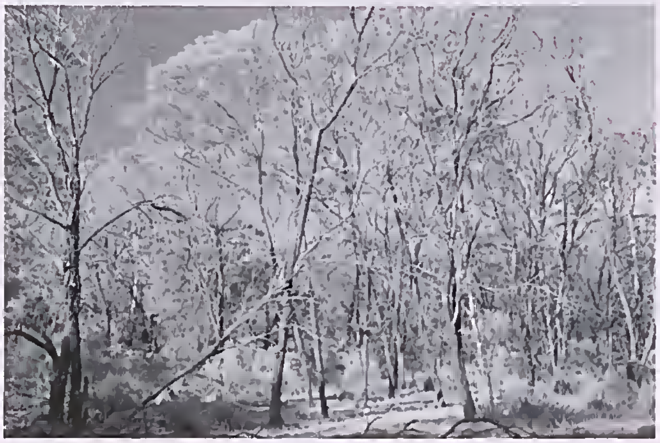

Fig. 78. ID476 *Acacia linearifolia – Eucalyptus dealbata* low open forest on a white claystone ridge north of Goolma in NSW SWS Bioregion (AGD66) 32°9'26.9"S 149°14'9.3"E. Photographer, Jaime Plaza, 12/5/09.

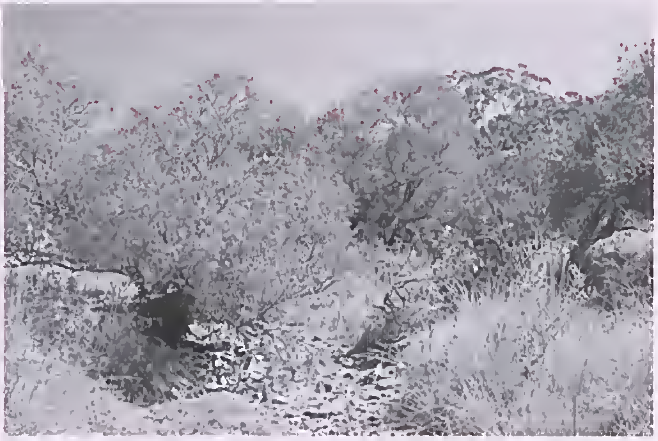

Fig. 79. ID333 *Callistemon sieberi* riparian shrubland with weedy ground cover on Wullumburrawing Creek on the property Balmerah west of Coonabarabran (AGD66) 31°22' 55.9"S, 149°3' 1.1"E. Photographer, Jaime Plaza, 23/3/09.

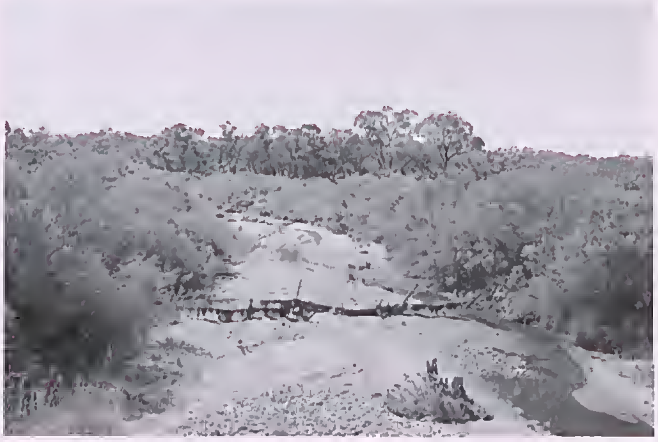

Fig. 80. ID574 *Leptospermum* spp. (tea-tree) riparian shrubland south-west of Tingha, west New England Bioregion (GDA94) 29°57' 49"S 151°11' 08"E. Photographer, P. Gilmour, 10/03/2008.

(Queensland Bluegrass). 100km to the south east of Moree on the Liverpool Plains, grassland was once very extensive but is now mostly cleared. These Liverpool Plains grasslands (ID102) (Figure 81) mainly occupy deep black earth, alluvial soils derived from basalt. They are listed as part of an Endangered Ecological Community. Their current floristic compostion is dominated by *Austrostipa aristiglumis* (Plains Grass), *Dichanthium sericeum* subsp. *sericeum*, *Austrodanthonia bipartita* and *Aristida leptopoda* and the daisy *Leiocarpa panaetioides*. Prior to European settlement and the introduction of domestic stock this grassland probably contained a higher cover of palatable grass species such as *Themeda avenacea* and *Eulalia aurea* (Lang 2008, Allen & Benson in prep.). In montane valleys on the New England Tableland small areas of snow grass-dominated grassland occur in valleys subject to cold air drainage (ID586) (Figure 82). These are now mainly cleared or heavily modified and are dominated by *Poa labillardierei* var. *labillardierei*, *Pennisetum alopecuroides*, *Carex appressa* and *Poa sieberiana*. Small patches of native grassland occur on rocky hills. Examples include ID427 containing *Cymbopogon refractus*, *Tripogon loliiformis*, *Enneapogon gracilis* and *Poa sieberiana* on volcanic outcrops with *Callitris*.

A few hummock (*Triodia*) native grasslands occur in the BBS/NAN Bioregions. ID117 occurs on deep sandy red earth soils in the Narran Lake region including in Narran Lake Nature Reserve. ID235 containing species such as *Triodia scariosa* subsp. *yelarbonensis*, *Aristida calycina* var. *calycina* and *Panicum simile* is a feature of sodic outwash soils between Yetman and Yelarbon in Queensland and ID460, dominated by *Triodia scariosa* subsp. *scariosa*, occurs in small patches on steep hills in the Mount Kaputar to Bingara region, especially on serpentinite and silcrete.

Derived native grasslands

Derived grasslands cover a large proportion of the NSW north western slopes and west-NET Bioregion. They cover a much higher proportion of the landscape compared to the NSW South-western Slopes Bioregion (see discussion in Benson 2008). While pasture "improvement" with exotic species is increasing, such introduced pastures probably cover less than 30% of the overall non-cropped area cleared of original woodland or forest cover (author's estimate). Derived grasslands are defined where >50% of the ground cover is composed of indigenous species as defined as native vegetation under the *NSW Native Vegetation Act* 2003. These grasslands can form a semi-natural matrix between natural remnants. They are generally classified broadly in the NSWVCA as floristic composition alters markedly with grazing intensity or history of crop cultivation.

An example of a widespread type of derived grassland at lower elevations, including in the Moree region, is Windmill Grass grassland (ID49) dominated by *Chloris truncata*, *Enteropogon acicularis*, *Enneapogon nigricans* and *Dactyloctenium radulans*. Derived *Austrostipa* (speargrass)-dominated grasslands are widespread at mid-elevations including ID395 in the vicinity of Coonabarabran and the Warrumbungle Range, ID451 in the northern part of the BBS and NAN Bioregions and ID484 on the slopes above and hills surrounding the Liverpool Plains. ID511 (Figure 83) is a common derived grassland on clay soils on hills and flats and is dominated by Queensland Bluegrass (*Dichanthium sericeum* subsp. *sericeum*) with *Bothriochloa macra* (Red Leg Grass), *Bothriochloa decipiens* and *Sporobolus creber* (Rats-tail Grass). Throughout the mid to lower elevations of the study area a derived wiregrass grassland (ID619) occurs in locations where White Box has been cleared. This contains grass species such as *Aristida personata*, *Aristida vagans*, *Aristida ramosa* and *Austrodanthonia bipartita*. At high elevations in the NET Bioregion, derived snow grass grassland (ID569) (Figure 84) occurs in areas cleared of trees

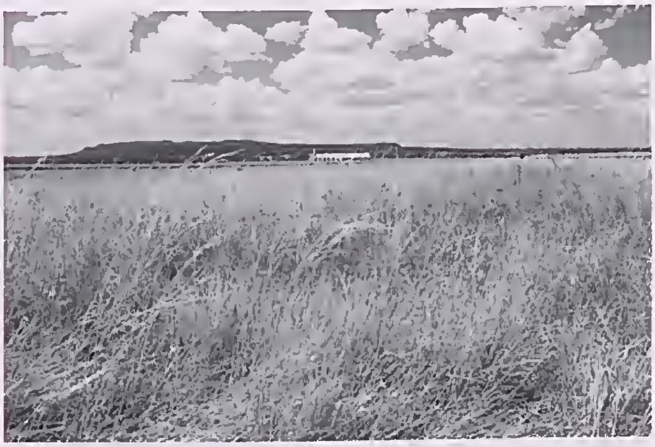

Fig. 81. ID102 Liverpool Plains grassland on black earth soil dominated by *Austrostipa aristiglumis* and *Dichanthium sericeum*, near Bundella (AGD66) 31°28' 53"S 150°5' 12.1"E. Photographer, Jaime Plaza, 19/3/09.

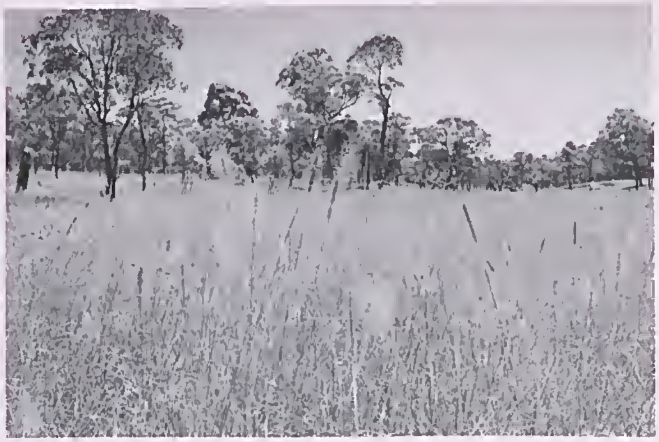

Fig. 82. ID586 Tussock grassland in a cold air drainage valley with *Poa labillardierei* var. *labillardierei* and *Pennisetum alopecuroides* in a TSR on Walcha-Niangala Road 0.5km S of MacDonald River (GDA94) 31°06' 60"S 151°26' 46"E. Photographer, P. Richards, 30/03/2008.

containing species such as *Poa sieberiana, Poa labillardierei* var. *labillardierei, Themeda australis, Sorghum leiocladum* and *Bothriochloa macra*.

Wetlands

With the exception of the two western outlying BBS subregions including Narran Lake, floodplains are less extensive compared to the Darling Riverine Plains Bioregion that adjoins the BBS Bioregion to the west. However, a number of wetland communities occur in the BBS Bioregion. Wetlands dominated by sedges occur along impeded creeks in valleys including on the western side of the NET Bioregion. On the clay floodplains of the most inland areas bordering the Darling Riverine Plains Bioregion, shallow sedge-dominated depressions occur (ID53). These are often surrounded by Coolabah woodland (ID40, ID39) with small areas of *Acacia stenophylla* (River Cooba) tall shrubland (ID241). *Muehlenbeckia florulenta* (Lignum) shrubland (ID247) (Figure 7), *Phragmites australis* (Common Reed) reedland (ID181) and *Typha* (Cumbungi) rushland (ID182) occur in regularly flooded areas with small areas of *Aeschynomene indica* (Budda Pea) and Channel Millet (*Echinochloa inundata*) (ID375) occurring in channels with Coolabah woodland north of Walgett.

Small patches of floristically distinct wetland, dominated by *Nyphoides, Ottellia* and sedge species, occupy depressions on sodic soils in the Yetman region (ID364) (Figure 85). These grade into *Melaleuca densispicata* Swamp Paper-bark (ID363) (Figure 86) open shrubland on sodic outwash scalds. Both ID363 and ID 364 extend from Yetman to Yelarbon in Queensland where the landscape is colloquially known as the "Yelarbon Desert" (Fensham *et al.* 2007).

An unusual wetland restricted to the BBS Bioregion occurs in "tank gilgai" that are formed on cracking, clay, alluvial soils in the north-western Pilliga Scrub forests extending north into the Darling Riverine Plains Bioregion (ID416) (Figure 87). This wetland is dominated by species such as *Pseudoraphis spinescens, Panicum decompositum, Juncus aridicola, Cyperus gunnii* subsp. *gunnii, Eleocharis pusilla, Marsilea hirsuta* and the critically endangered *Myriophyllum implicatum* that was recently discovered in NSW during our surveys. The "tank" gilgais can be over one hectare in size forming a chain of ponds that may be important for migratory wetland bird species. ID416 grades into a very restricted Pilliga forest *Allocasuarina luehmannii* (Buloke) – Swamp Paper-bark low woodland / tall shrubland (ID410) on outwash sodic soils that is similar to ID363 in the Yetman region, described above.

In addition to the alluvial plains sedgeland ID53 mentioned above, several sedgeland wetlands are present in valleys and along creeks. ID447 occurs in shallow depressions in the Coolatai region such as in Arakoola Nature Reserve. The Juncas and sedge-dominated ID400 (Figure 88) occurs along sandy creeks in the western Pilliga forests and a similar community ID361 occurs in the southern Pilliga and Warrumbungle areas near Coonabarabran. A highly restricted and possibly unique wetland occurs on an impeded creek at Ulungra Springs near Mendooran (ID465). It is dominated by *Typha domingensis, Phragmites australis, Pennisetum alopecuroides, Poa labillardierei* var. *labillardierei* and a range of sedges. At higher elevations extending into the western NET Bioregion, a sedgeland fen community is present in shallow basins and impeded creeks (ID582) (Figure 89). This is dominated by *Carex appressa, Carex gaudichaudiana, Scirpus polystachyus, Stellaria angustifolia* and *Carex tereticaulis*. Other high elevation wetlands include ID497 (Figure 90) in swamps on the basaltic Liverpool Range that is dominated by a shrub layer of *Leptospermum gregarium* and *Hakea microcarpa* with a ground cover of *Gratiola peruviana, Stellaria angustifolia, Cyperus sphaeroideus, Ranunculus inundatus, Hydrocotyle peduncularis* and *Isotoma fluviatilis* subsp. *fluviatilis*. In the west NET Bioregion a montane wetland (ID500) (Figure 91) occurs in plateau lakes. This is dominated by *Eleocharis acuta, Glyceria australis, Carex gaudichaudiana* and *Lachnagrostis filiformis*. A greater number of fen and bog wetland types occur to the east of the Great Dividing Range in the NET Bioregion. These are not covered in this version of the NSWVCA.

Protected areas in the BBS, NAN and west New England Bioregions

As of June 2010, the BBS/NAN/west NET bioregions contained a total of 136 protected areas (Table 6, Figure 92) comprising 115 public conservation reserves and at least 21 secure property agreements. Most of these protected areas are shown in Figure 93. The summed area of these protected areas is 659 934 hectares or 7.11% of the area (Table 6). For NSW as a whole, over 347 340 hectares of land have been

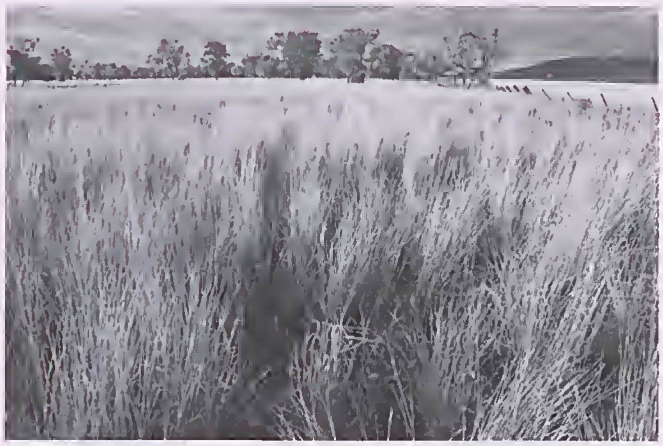

Fig. 83. ID511 *Dichanthium sericeum* subsp. *sericeum* – *Bothriochloa* spp. – *Austrostipa aristiglumis* derived grassland on alluvial soils north of Narrabri. Photographer, Jaime Plaza, 21/8/2008.

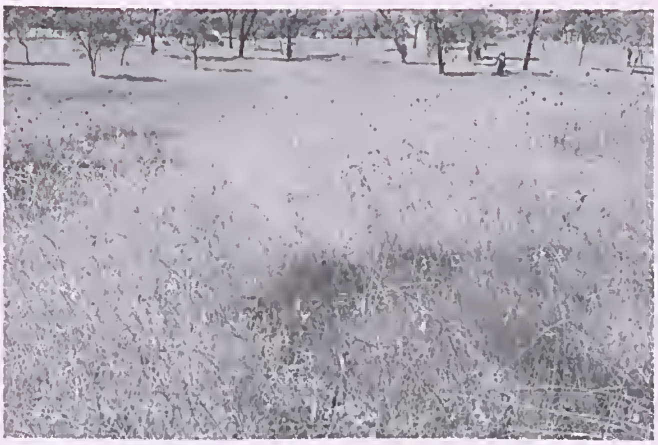

Fig. 84. ID569 *Poa sieberiana* (snow grass) – *Themeda australis* (Kangaroo Grass) derived grassland on the New England Tableland, TSR on Walcha-Niangala Road 0.5km S of MacDonald River (GDA94) 31°06' 60"S 151°26' 46"E. Photographer, P. Richards, 30/03/2008.

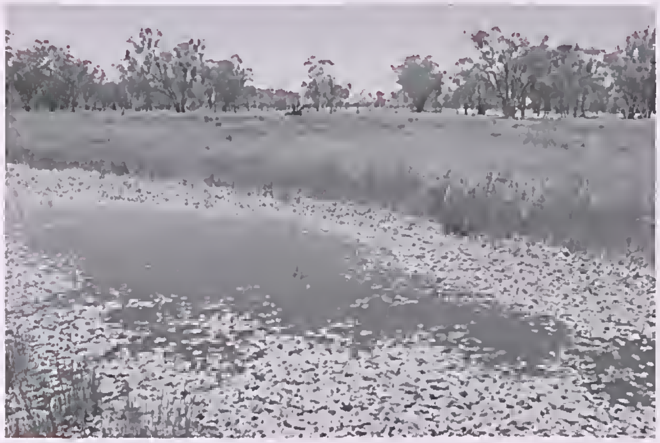

Fig. 85. ID364 Freshwater wetland with water-plants in small depressions on sodic soils in the Yetman region (agd66) 28°40' 42.9"S 150°43' 47.7"E. Photographer, Jaime Plaza, 14/11/07.

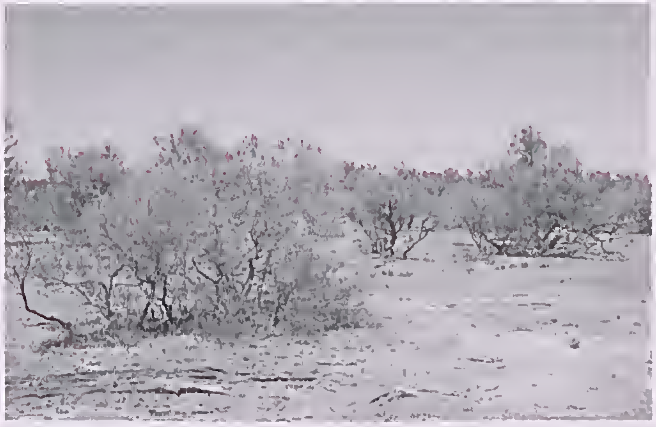

Fig. 86. ID363 *Melaleuca densispicata* (Swamp Paper-bark) sodic scald wetland / shrubland on the Yetman – Yalarbon Road (agd66) 28°46' 50.1"S 150°43' 19.9"E. Photographer, Jaime Plaza, 14/11/07.

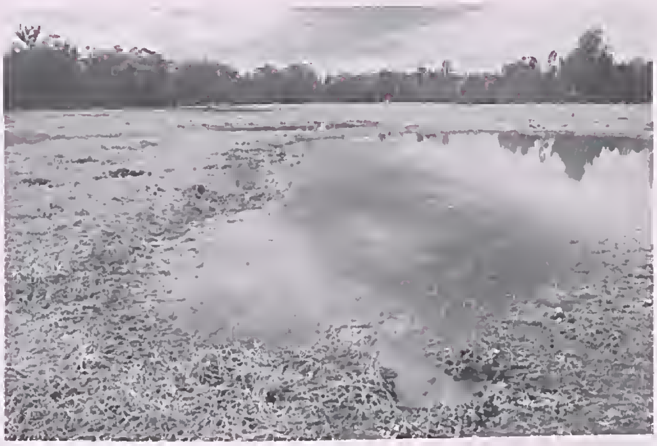

Fig. 87. ID416 "Tank Gilgai" wetland in Pilliga National Park, north-west Pilliga forests (AGD66) 30°30' 22.8"S, 149°22' 16.5"E. Photographer, Jaime Plaza, 25/8/2008.

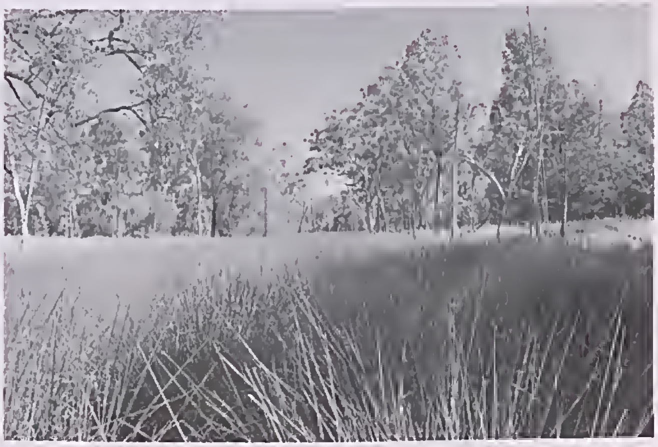

Fig. 88. ID400 *Cyperus* spp – *Juncus aridicola* sedgeland wetland, Merriwee Creek West Pilliga (AGD66) 30°35' 43.7"S 148°55' 39"E. Photograph, Jaime Plaza, 4/05/08.

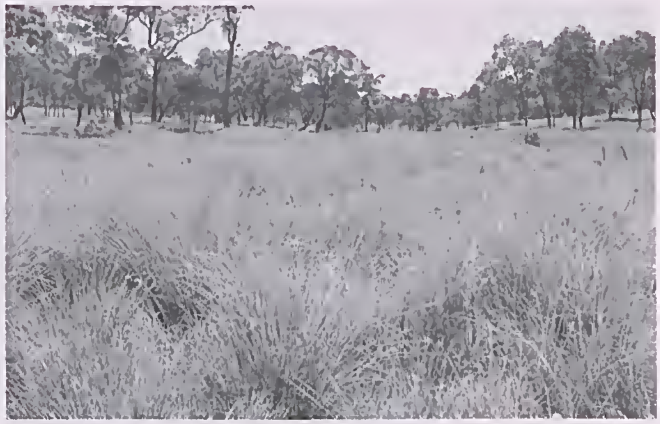

Fig. 89. ID582 Tussock *Carex* spp. sedge fens in a valley with impeded drainage, TSR on Walcha-Niangala Road 0.5km S of MacDonald River (GDA94) 31°06' 60"S 151°26' 46"E. Photographer, P. Richards, 30/03/2008.

added to the conservation reserve system in NSW between mid–2008 and mid–2010 (compare Table 6 here to Table 6 on page 648 in Benson 2008). This excludes the 100 000 hectares of new River Red Gum Reserves mainly in the Riverina Bioregion that were announced in May 2010. Over 9.1% of NSW is now in protected areas.

If it is assumed that approximately 35% of woody native vegetation remains in the BBS/NAN and west NET Bioregions (i.e. approx. 3,250,000 ha) then approximately 20% (over 600 000 ha) of this is in protected areas (some areas of non-woody native vegetation types are also in protected areas). The average size of all protected areas is 4852 hectares with National Parks, State Conseration Areas and Nature Reserves larger than secure property agreements (Figure 92). In fact, secure property agreements comprise a small amount (8493 hectares or 1.3%) of the overall protected area system, highlighting a need to increase their number and coverage through various NSW private land conservation initatives.

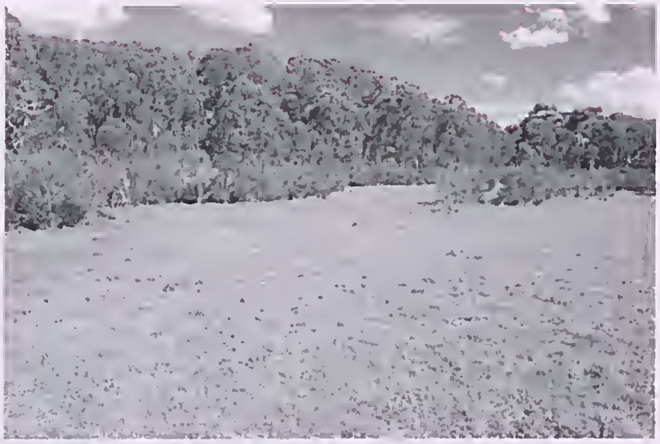

Fig. 90. ID497 *Leptospermum gregarium – Eleocharis dietrichiana – Gratiola peruviana – Pratia pedunculata* swamp in Coolah Tops National Park (AGD66) 31°44' 44.2"S 150°1' 39.7"E. Photographer, Jaime Plaza, 24/3/09.

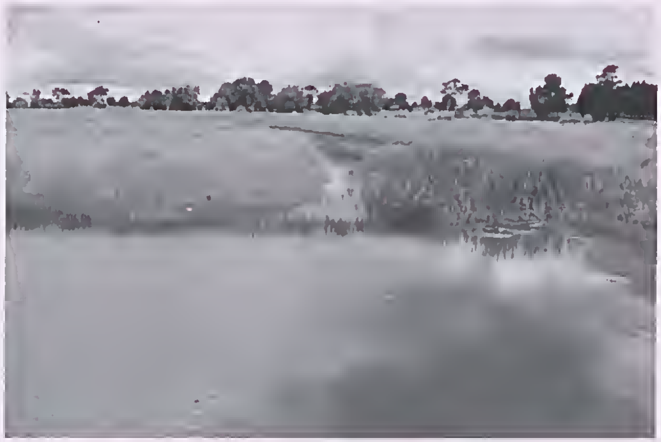

Fig. 91. ID500 Upland wetlands of the New England Tablelands, Mother of Ducks Lagoon, Guyra (GDA94) 30°13' 24"S 151°40' 03"E. Photographer, P. Richards, 14/12/2007.

As of April 2010, the protected areas in the BBS/NAN/west NET Bioregions included 42 National Parks (including CCAZ1), 39 Nature Reserves, 26 State Conservation Areas (including CCAZ3), six Aboriginal Areas (including CCAZ2), two Flora Reserves under the *NSW Forestry Act* 1916 and 15 Conservation Agreements (VCAs) under the *NSW National Parks and Wildlife Act* 1974. A number of secure (99 year) property agreements have been entered into under the previous *NSW Native Vegetation Conservation Act* 1998 or the *Native Vegetation Act* 2003 where they contained areas with appropriate management codes to maintain or improve native vegetation. However, at this stage, few of these *Native Vegetation Act* 2003 secure property agreements are recorded in the NSWVCA database due to the difficulty of accessing records. Minor additions to the protected area status of a number of plant communities would be made if all secure property agreements under the *Native Vegetation Act* 2003 were collated into the database. Three secure caveats under the *NSW Nature Conservation Trust Act* 2001 are also in the area.

A number of protected areas overlap or occur near to the boundary of the BBS Bioregion. Narran Lake Nature Reserve is split between the BBS and the previously classified Darling Riverine Plains Bioregion and is fully covered here. Dapper Nature Reserve and Goodiman State Conservation Area overlap into the NSW South-western Slopes Bioregion and are fully covered here. Durrigerie SCA, Goulburn River National Park and Towarri National Park overlap into the Sydney Basin Bioregion. Durridgerie SCA is covered as it mainly occurs in the BBS Bioregion. Goulburn River NP is mainly in the Sydney Basin Bioregion so is not covered in this version of the NSWVCA and has close affinities to the sandstone landscapes in Wollemi NP and other parts of the Sydney Basin Bioregion. The northern half of Towarri NP on the Liverpool Range is in the BBS Bioregion and is covered but not the southern half which contains several plant communities confined to the Sydney Basin Bioregion. A number of conservation reserves are adjacent to or straddle the boundary of the Nandewar and Sydney Basin Bioregions or Nandewar east-New England Tableland region including Manobalai NR, Wingen Maid NR, Wallabadah NR, Tomalla NR, Back River NR and Ben Halls Gap NP. These are not covered in this version of the NSWVCA.

As the NSWVCA expands to cover eastern NSW, plant communities in the reserves adjoining the bioregions covered here will be assessed and the protected area extent statistics for plant communities in the NSWVCA database will be modified.

Of the 315 communitues, 31 (10%) plant communities are not sampled in protected areas; 82 (26%) have < 1%, 147 (47%) have < 5%, 171 (55%) have < 10% and

Table 6. Number and different types of protected areas in the BBS, NAN and western NET

Notes. The figures exclude marine parks in coastal waters of NSW, land in Crown Reserves managed by DECCW in eastern NSW and Goulburn River National Park from the statistics in the BBS, NAN and west-NET Bioregions. DECCW Acquired lands are allocated to reserve types based on advice from DECCW Parks and Wildlife Division.

The Brigalow Belt South Bioregion Forest Assessment "Community Conservation Areas" Zones 1-4 (CCAZ) are allocated to National Park, Aboriginal Area, State conservation Area or Nature Reserve categories. Data sources are: DECCW Estates and Acquired Lands GIS layer April 2010

Protected Area Type	**No. in NSW**	**Area (ha) in NSW**	**% of NSW**	**No. in BBS, NAN & W NET**	**Area (ha) in BBS, NAN & W NET**	**% of BBS, NAN & W NET**
Aboriginal Areas	24	34,129	0.043	6	21521	0.232
Historic Sites	15	3,228	0.004			
Karst Conservation Reserves	4	5,259	0.007			
National Parks	215	5,333,700	6.672	42	258169	2.783
Nature Reserves	378	946,788	1.184	39	149976	1.617
State Conservation Areas	132	640,211	0.801	26	219584	2.367
Total all DECCW reserves	**768**	**6,963,314**	**8.711**	**113**	**649249.562**	**6.998**
Flora Reserves	23	216,670	0.271	2	2191	0.024
Total all public reserves	**791**	**7,179,984**	**8.982**	**115**	**651440.974**	**7.022**
Secure PAs (NVC Act)	59	44,577	0.056	6	4146	0.045
VCAs (NPW Act)*	249	52,197	0.065	15	4347	0.047
Bush Heritage Reserves	5	2,396	0.003			
Total non-public protected areas	**313**	**99,171**	**0.124**	**21**	**8,493**	**0.092**
Total for all protected areas	***1,104***	***7,279,155***	***9.11***	***136***	***659,934***	***7.11***

Table 7. BBS, NAN and west-NET Bioregions plant communities identified by their NSWVCA database ID number listed under a range of proportions of estimated percent of pre-European extent in protected areas.

Note: Communities considered to be derived are in the 50-100% category because it is considered they either did not exist in 1788 or have expanded.

Protected pre-European Extent	**BBS, NAN and w-NET VCA Veg. ID Numbers**	**No.**
0%	102, 227, 228, 387, 433, 436, 437, 438, 439, 441, 442, 453, 462, 463, 464, 465, 466, 475, 483, 513, 515, 529, 555, 566, 573, 580, 583, 619, 623, 627, 629	31
>0 - <0.2%	27, 50, 56, 70, 101, 145, 192, 238, 244, 333, 461, 507, 516, 517, 534, 554, 563, 571, 586, 590, 599	21
0.2 - <0.5%	35, 55, 114, 195, 381, 444, 472, 510, 533, 589, 593	11
0.5 - <1%	52, 87, 135, 281, 364, 420, 452, 489, 512, 542, 556, 559, 565, 567, 582, 591, 595, 618, 632	19
1 - <2%	37, 43, 53, 71, 77, 78, 168, 202, 241, 247, 249, 412, 434, 435, 485, 488, 504, 505, 508, 509, 537, 538, 541, 551, 552, 577, 588, 606	28
2 - <5%	36, 62, 81, 98, 113, 118, 120, 146, 147, 204, 206, 255, 363, 378, 445, 447, 474, 476, 486, 500, 501, 502, 503, 519, 520, 523, 527, 528, 539, 540, 544, 564, 568, 594, 608, 626, 628	37
5 - <10%	40, 49, 84, 134, 144, 211, 362, 375, 383, 396, 403, 413, 421, 430, 431, 454, 456, 496, 549, 562, 584, 596, 612, 617	24
10 - <15%	117, 148, 212, 376, 414, 446, 450, 455, 478, 514, 532, 543, 545, 574, 578, 581, 592, 597, 598, 605, 625	21
15 - <20%	112, 367, 368, 374, 377, 404, 428, 429, 440, 443, 449, 451, 459, 479, 492, 493, 495, 506, 558, 575, 579, 607, 621, 622, 624	25
20 - <50%	88, 141, 179, 235, 256, 361, 370, 372, 373, 379, 382, 384, 385, 393, 394, 397, 398, 399, 400, 401, 402, 405, 406, 407, 408, 409, 411, 415, 416, 417, 422, 424, 427, 432, 448, 457, 458, 460, 467, 468, 469, 470, 471, 473, 477, 480, 481, 482, 487, 490, 491, 494, 498, 499, 535, 536, 547, 548, 557, 561, 572, 576, 585, 600, 609, 610, 611, 616, 620	69
50 - <100%	366, 369, 371, 380, 386, 388, 389, 390, 391, 392, 395, 410, 418, 419, 423, 425, 484, 497, 511, 521, 525, 530, 531, 550, 569, 587, 613, 614, 615	29

Table 8. Number of plant communities in the BBS, NAN and west-NET Bioregions with threat categories in relation to protected area codes.

Notes: Explanations of the protected area and threat codes are provided in Benson (2006). See Appendix B in Benson (2006) for explanation of the threat categories.

	No. of Extant NSW Plant Communities															
	Protected Area Code															
Threat Category	1a	1b	1c	2a	2b	2c	3a	3b	3c	4a	4b	4c	5a	5b	5c	Total
Critically Endangered	-	-	-	-	-	-	-	-	-	1	-	1	5	4	4	15
Endangered	-	-	-	-	-	-	-	-	1	11	2	1	21	17	6	59
Vulnerable	-	-	1	-	-	3	3	2	1	17	7	2	9	7	8	60
Near Threatened	6	1	-	6	5	5	10	9	6	11	7	6	8	11	8	99
Least Concern	21	7	2	7	12	2	6	4	7	4	3	2	5	-	-	82
Total	27	8	3	13	17	10	19	15	15	44	19	12	48	39	26	315

192 (62%) have < 15% of their pre-European extent in protected areas (Table 7). If 10% of pre-European extent in protected areas is set as an adequacy target based on the Commonwealth Government's National Reserve System program (Commonwealth Government 1999), 144 (46%) of the communities are adequately protected. This is supported by the distribution of communities in protected area codes in Table 8. Assuming that the protected area codes 1a, 1b, 1c, 2a, 2b, 2c, 3a, 3b, 3c (Table 8) represent moderate to high representation in protected areas (as defined in pages 372–373 in Benson 2006), then 127 (40%) of the 315 plant communities fall into these categories (Table 8).

The protected area status of the 315 plant communities in the BBS, NAN and west-NET Bioregions is proportionally higher than that the protected area status of plant communities in NSW Western Plains as reported in Benson *et al.* (2006) and the NSW South-western Slopes Bioreion as reported in Benson (2008). As mentioned above, substantial additions to the reserve system in 2005 greatly improved the protected area status of some plant communities.

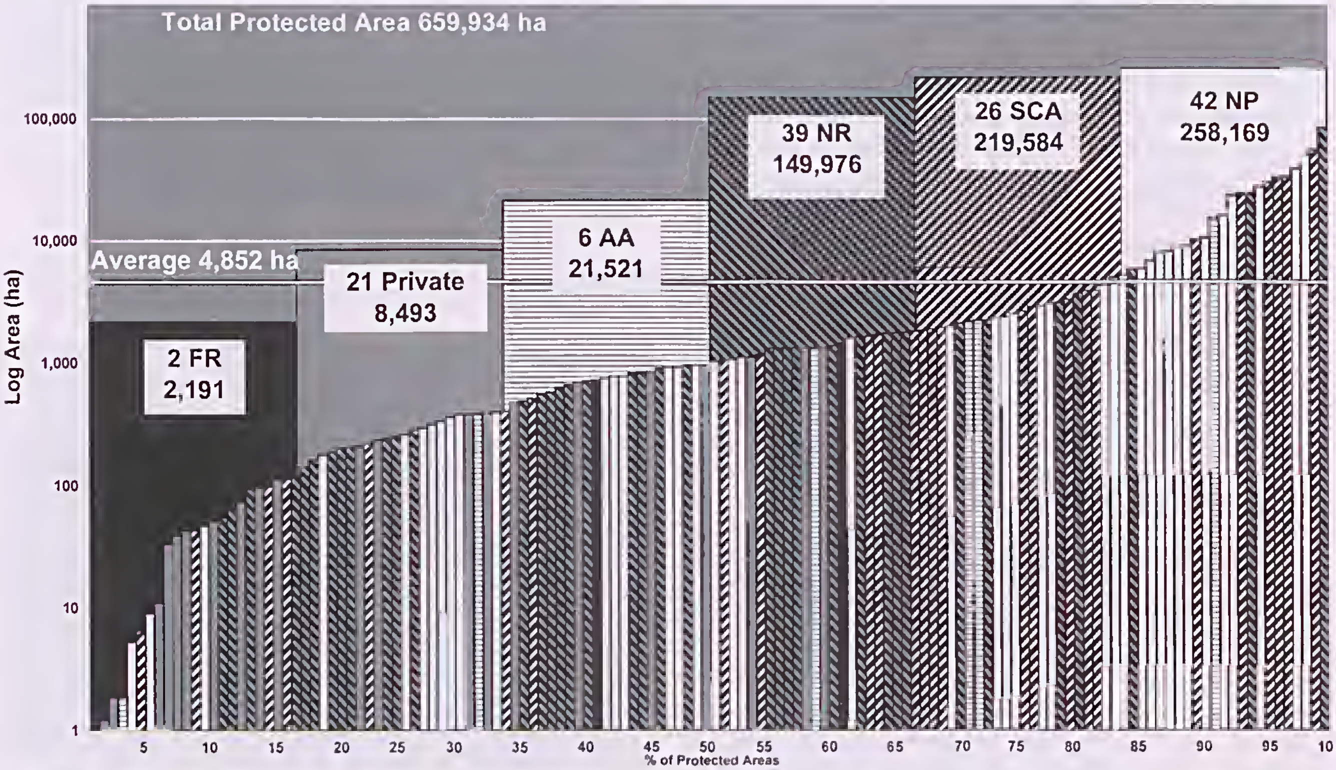

Fig. 92. Size in hectares of protected areas in the BBS, NAN and west-NET Bioregions as of April 2010 assuming all DECCW acquired lands at that time are added to reserves. This includes parts of protected areas that overlap with other bioregions with the exception of Goulburn River National Park which is excluded. Thin columns in foreground are the areas of individual protected areas. Wide columns in background contain the cumulative area for each type of protected area. The number, type and area of each protected area type are shown in the white boxes. Columns are: diamonds = Historic Sites, light grey = Flora Reserves, black = Aboriginal Area, dark grey = State Conservation Areas, brick pattern = secure property agreements under *National Parks and Wildlife Act* 1974, *Nature Conservation Trust* 2001 and *Native Vegetation Act* 2003, white = Nature Reserves, and diagonal stripe = National Parks.

Most of the plant communities with > 10% of their pre-European extent in protected occur on sandstone substrates in the Pilliga Scrub, Goonoo forests and Yetman forests or on acid volcanic substrates in locations such as the Warrumbungle Range, Mount Kaputar, Kings Plains, Severn River and hills near Ashford. Native grasslands and grassy woodlands that occur on high nutrient soils, including on soils derived from basalt and alluvium occurring on plains, floodplains, alluvial plains, valley flats and on low undulating hills are mainly cleared and cropped and consequently are very poorly sampled in the protected area system.

Assessment of threats to the vegetation

Clearing of over 60% of the BBS/NAN/west-NET Bioregions (Figure 4) has mainly focussed on grassy woodlands and native grasslands and lead to their severe fragmentation and loss of extent. An increasing threat is the conversion of native ground cover in grassy open woodland or woodland to exotic pasture or crops. While pasture "improvement" using exotic species is less prevalent in proportional area compared to the NSW South-western Slopes Bioregion, it is accelerating in parts of the NET and NAN Bioregions. Expanded irrigated and dryland cropping is an intensification of agriculture that substantially affects native vegetation on rich soils on flat or undulating terrain (Figures 94 & 95). The expansion of cropping over the last decade is documented in a cropping history mapping database available through http://canri.nsw.gov.au/nrdd/records/ANZNS0208000228.html. One consequence of exotic pasture, fertilizer application and clearing is episodic tree dieback that has particularly affected grassy woodlands in the New England Tableland since the 1970s (Nadolny 1995). Current increase in populations of

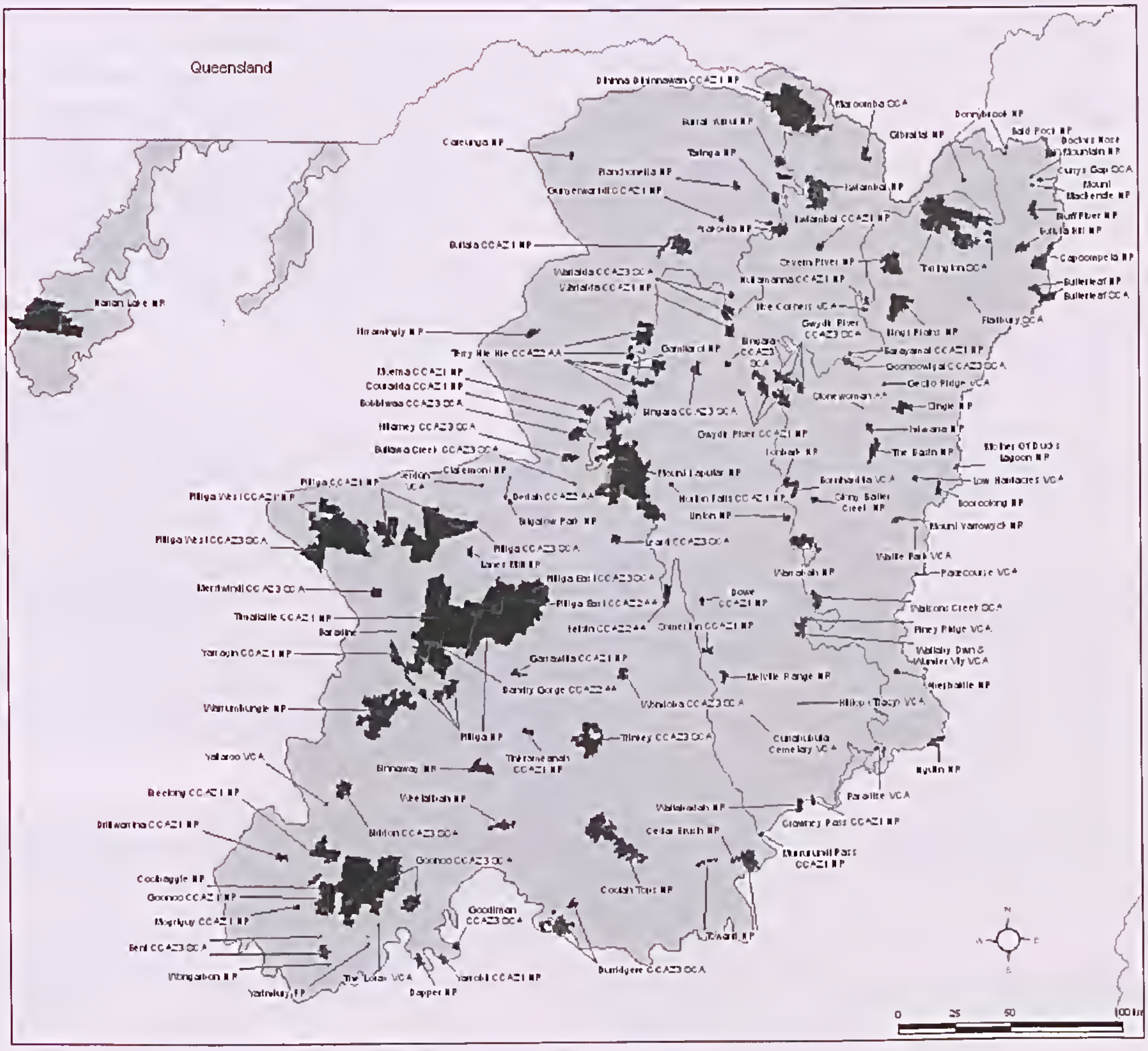

Fig. 93. Protected areas in the BBS, NAN and west-NET Bioregions in mid-2010 showing conservation reserves managed by DECCW NSW, Flora Reserves managed by NSW State Forests and some secure property agreements on private land including voluntary Conservation Agreements (VCAs).

insect species that cause dieback, indicates that another episode of tree dieback may impact on NET woodlands (Nadolny pers. comm.). Tree dieback is also present in water-stressed riparian or floodplain woodlands including River Red Gum woodland (Figure 96).

A major threat to grassy woodlands and grasslands is the invasion of exotic weed species. The most aggressive of these is the North African / Middle Eastern grass *Hyparrhenia hirta* (Coolatai Grass) (Figure 97). Since its introduction in the 1940s this species has spread rapidly, particularly on rich soils in the northern parts of the BBS and NAN Bioregions. Coolatai Grass is difficult to manage as it is resistant to some herbicides, is not very palatable to stock when mature and seeding and it can invade beyond roadside infestations into native vegetation (McArdle *et al.* 2004, Nadolny 2006). Climatic modelling of its potential spread (Chejara et al. 2010) indicates that Coolatai Grass is a threat to a large area of southern Australia including native grasslands around Moree and on the Liverpool Plains that have already been cleared to small proportions of their original extent. In contrast to the situation of Coolatai Grass, one of the greatest introduced plant pests of the early 20th Century, the cactus *Opuntia stricta* (Prickly Pear) (Figure 98), has been brought under control by the *Cactoblastis* insect.

Extensive logging has reduced the original tree size classes in forests on basalt soils on the Liverpool Range and in the widespread open forests and woodlands of ironbark and cypress pine in the sandstone country between Dubbo and Yetman (Figure 99). In some areas, the practice of 'timber stand improvement' has altered canopy composition by removing the less commercially important species, such as eucalypt box species (*Eucalyptus microcarpa, E. albens, E. melliodora*), to encourage the preferential regeneration of commercially valuable tree species such as *Callitris glaucophylla* (White Cypress Pine) and *Eucalyptus crebra* (Narrow-leaved Ironbark). Felling living and dead trees for fire-wood has affected woodland areas near major towns including to the west of Armidale on the New England Tableland (Wall 1997). Fire wood is also cut for city markets in some privately owned woodland on the north-western slopes.

Clearing and fragmentation over the last 100 years prevents widespread wildfires burning large regions with the exception of the Pilliga (Figure 100), Goonoo and Torrington woodlands and forests. Shrubby woodlands and forests contain shrub species that require time for growth and seed production. Wildfire occurs every few decades in the Pilliga Scrub, Goonoo and other forests near Dubbo and in the shrubby woodlands in the Howell-Tingha region. In comparison, fire is now rare in fragmented grassy woodland remnants that may have been subjected to low intensity patch burns by Aboriginal people before European settlement.

Mining has destroyed areas of Poplar box – White Cypress Pine – Ironwood woodland at Lightning Ridge and surrounding regions. However, its greatest impact is occurring in the Gunnedah Basin including in the Liverpool Plains IBRA sub-region where coal mining is expanding rapidly. This mining is impacting on a range of shrubby woodlands on hills and grassy woodlands on plains. Mining of asbestos at Woodsreef has impacted on the restricted *Triodia* and *Xanthorrhoea*-dominated vegetation type there.

Overall, a lower proportion of a plant communities are assessed as being threatened (critically endangered, endangered, vulnerable) in applying the NSWVCA threat criteria (Appendix B in Benson 2006) compared to the NSW South-western Slopes Bioregion assessed in Benson (2008). Applying these threat criteria to the 315 BBS/NAN/west NET Bioregions plant communities resulted in 15 communities being considered as critically endangered (CE), 59 endangered (E), 60 vulnerable (V), 99 near threatened (NT) and 82 least concern (LC) (Table 8). This implies that 43% of the plant communities fall into the threatened categories (CE, E, or V).

The *Listed Under Legislation* field has been altered in Version 3 of the NSWVCA database to record the Endangered Ecological Community (EEC) under the NSW *Threatened Species Conservation Act* and/or the Threatened Ecological Community (TEC) under the Commonwealth *Environmental Protection and Biodiversity Conservation Act* that align with a VCA plant community. Most VCA communities that are assessed as correlating to a listed or nominated EEC/TEC are recorded as being "part" of an EEC or TEC because most EECs and TECs are more broadly classified compared to the NSWVCA classification.

As of April 2010, 61 of the 315 plant communities were part or equivalent to endangered (or threatened) ecological community (EEC/TEC) listings (Table 9). Of these, 50 were listed as EECs under the NSW *Threatened Species Act* 1995 (TSC Act) and 35 under the Australian *Environmental Protection and Biodiversity Conservation Act* 1999 (Table 9) (some are listed under both laws). Concerning nominated EECs, as of June 2010 six plant communities are included in nominated EEC listings in the TSC Act and four in TEC nominations to the EPBC Act (Table 9). A number of other NSWVCA plant communities classified in the area warrant nomination and listing as EECs based on the threat assessment in the NSWVCA.

The number of plant communities in different NSWVCA threat categories in the nine CMA areas so far completely or partially covered in the NSWVCA are presented in Table 10. This updates similar data presented for western CMAs in Version 2 of the NSWVCA (Benson 2008). A total of 245 (42%) of the 585 communities, so far classified in the NSWVCA acros11.5 IBRA Bioregions, are threatened (CE, E or V). The threatening process fields in the NSWVCA database list or describe the type and degree of threats to each plant community.

Table 9. NSW Brigalow Belt South, Nandewar and west-New England Tableland IBRA Bioregion plant communities (61) that are part of Endangered Ecological Communities listed or nominated under the NSW Threatened Species Conservation Act 1995 and/or the Australian Environmental Protection and Biodiversity Conservation Act 1999 as of June 2010.
Note: The plant communities defined in the NSWVCA are labelled as being either "part" or "equivalent" to listed or nominated EECs. Of those correlating to EECs, most VCA plant communities are labelled as being "part" of an EEC.

ID No	Common Name	Listed, nominated under TSC or EPBC Acts
27	Weeping Myall open woodland of the Darling Riverine Plains and Brigalow Belt South Bioregions	Listed TSC Act, E: Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes Bioregions (Part); Listed EPBC Act, E: Weeping Myall Woodlands (Part);
35	Brigalow – Belah open forest or woodland on alluvial often gilgaied clay soil mainly in the Brigalow Belt South Bioregion	Listed TSC Act, E: Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (Part); Listed EPBC Act, E: Brigalow (Acacia harpophylla dominant and co-dominant) (Part);
37	Black Box woodland wetland on NSW central and northern floodplains including the DRP and BBS Bioregions.	Nominated Commonweath EPBC Act; Listed TSC Act, E: Coolibah – Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South Bioregions (Part);
40	Coolabah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains	Nominated Commonweath EPBC Act; Listed TSC Act, E: Coolibah - Black Box Woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South Bioregions (Part);
43	Mitchell Grass grassland – chenopod low open shrubland on floodplains in the semi-arid (hot) and arid zones	Listed EPBC Act, CE: Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland (Part);
52	Queensland Bluegrass -/+ Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plain Bioregion	Listed EPBC Act, CE: Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland (Part);
71	Carbeen – White Cypress Pine – River Red Gum – bloodwood tall woodland on sandy loam alluvial and aeolian soils in the northern BBS and DRP Bioregions	Listed TSC Act, E: Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions (Part);
77	Yarran shrubland of the NSW central to northern slopes and plains	Nominated NSW TSC Act;
81	Western Grey Box – cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion	Listed TSC Act, E: Western Grey Box Woodland in the Riverina, NSW South Western Slopes, Cobar Peneplain, Nandewar and Brigalow Belt South Bioregions (Part); Listed EPBC Act, E: Grey Box (Eucalyptus microcarpa) Grassy Woodlands and Derived Native Grasslands of South-eastern Australia (Part);
101	Poplar Box – Yellow Box – Grey Box grassy woodland / open woodland on dark cracking clay soils in the Brigalow Belt South Bioregion	Listed TSC Act, E: Native Vegetation on Cracking Clay Soils of the Liverpool Plains (Part); Probably Listed EPBC Act, CE: White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
102	Liverpool Plains grassland on basalt-derived black earth soils, Brigalow Belt South Bioregion	Listed TSC Act, E: Native Vegetation on Cracking Clay Soils of the Liverpool Plains (Part); Listed EPBC Act, CE: Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland (Part);
113	Ooline closed forest on sandstone and conglomerate rises and hills in the Brigalow Belt South Bioregion	Listed TSC Act, E: Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South Bioregions (Part); Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
114	Ooline open forest on claystone mainly in the Nandewar Bioregion	Listed TSC Act, E: Cadellia pentastylis (Ooline) community in the Nandewar and Brigalow Belt South Bioregions (Part); Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
147	Mock Olive – Wilga – Peach Bush – Carissa semi-evergreen vine thicket mainly on basalt soils in the Brigalow Belt South Bioregion	Listed TSC Act, E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part); Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);

ID No	Common Name	Listed, nominated under TSC or EPBC Acts
202	Fuzzy Box woodland on colluvium and alluvial flats in the Brigalow Belt South (including Pilliga) and Nandewar Bioregions	Listed TSC Act, E: Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions (Part);
228	Semi-mesic woodland on basalt hills of the dry subtropical climate zone, north western slopes of NSW	Listed TSC Act, E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part); Probably part of Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
281	Rough-Barked Apple – red gum – Yellow Box woodland on alluvial clay to loam soils on valley flats in the northern NSWSWS and BBS Bioregions	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part); Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
361	Sedgeland fen wetland of spring-fed or runoff-fed creeks in the southern Pilliga – Warrumbungles region. Brigalow Belt South Bioregion	Nominated NSW TSC Act;
378	Belah – Wilga -+ White Box dry viney scrub woodland the NSW Brigalow Belt South Bioregion	Listed TSC Act, E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part); Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
388	Rusty Fig – Mock Olive – Red Ash vine dry rainforest on siliceous substrates in the Brigalow Belt South Bioregion	Listed TSC Act, E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part); Probably included in Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
421	Yellow Box – White Cypress Pine alluvial terrace flats grassy woodland in the Pilliga forests and surrounds, BBS Bioregion	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part); Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
428	Carbeen – White Cypress Pine – Curracabah – White Box tall woodland on sand in the Narrabri – Warialda region of the Brigalow Belt South Bioregion	Listed TSC Act. E: Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions (Part);
433	White Box grassy woodland to open woodland on basalt flats in the Liverpool Plains sub-region, BBS Bioregion	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part); Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
434	White Box grass shrub hill woodland on clay to loam soils on volcanic and sedimentary hills in the southern BBS Bioregion	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part); Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
437	Yellow Box grassy woodland on lower hillslopes and valley flats in the southern NSW BBS Bioregion	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part): Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
441	Carbeen – White Box +/- Silver-leaved Ironbark grassy tall woodland on basalt hills, BBS Bioregion	Listed TSC Act, E: Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions (Part);
442	Carbeen tall open woodland – Mock Olive tall closed vine thicket on basalt hills in the Northern Basalt sub-region, BBS Bioregion	Listed TSC Act. E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part); Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
445	Brigalow viney scrub open forest on loamy soils in low hill landscapes in the northern BBS Bioregion NSW	Listed TSC Act, E: Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (Part); Listed EPBC Act, E: Brigalow (Acacia harpophylla dominant and co-dominant) (Part);
452	Mixed vine thicket low eucalypt woodland of the northern-western Brigalow Belt South Bioregion (NSW)	Listed TSC Act, E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part); Probably part of Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
483	Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part); Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
496	Yellow Box – White Box – Silvertop Stringybark – Blakley's Red Gum grass shrub woodland mainly on the Liverpool Range, BBS Bioregion	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part); Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);

ID No	Common Name	Listed, nominated under TSC or EPBC Acts
500	Upland wetlands of the New England Tablelands Bioregion	Listed EPBC Act, E: Upland Wetlands of the New England Tablelands and the Monaro Plateau (Equivalent); Listed TSC Act, E: Upland Wetlands of the Drainage Divide of the New England Tableland Bioregion (Equivalent);
507	Black Sallee – Snow Gum grassy woodland of the New England Tablelands Bioregion	Listed TSC Act, E: Ribbon Gum – Mountain Gum – Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (Part);
508	Blakely's Red Gum – Stringybark – Rough-barked Apple open forest of the Nandewar and western New England Tablelands Bioregions	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
509	Blakely's Red Gum – White Cypress Pine – Rough-barked Apple grassy open forest of drainage lines of the northern Nandewar and New England Tablelands Bioregions	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
510	Blakely's Red Gum – Yellow Box grassy woodland of the New England Tablelands Bioregion	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
513	Candlebark – Ribbon Gum grassy woodland of the New England Tablelands Bioregion	Listed TSC Act, E: Ribbon Gum – Mountain Gum – Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (Part);
519	Heathy shrubland of the Howell area of the New England Tablelands Bioregion	Listed TSC Act, E: Howell Shrublands in the New England Tableland and Nandewar Bioregions (Equivalent);
523	McKie's Stringybark – Western New England Blackbutt – Rough-barked Apple open forest of the New England Tablelands Bioregion	Listed TSC Act, E: McKies Stringybark/Blackbutt Open Forest in the Nandewar and New England Tableland Bioregions (Equivalent);
527	Mugga Ironbark – Black Cypress Pine shrubby open forest mainly in the Nandewar and northern Brigalow Belt South Bioregions	Nominated NSW TSC Act;
528	Mugga Ironbark – Blakely's Red Gum open forest of the Nandewar and New England Tablelands Bioregions	Nominated NSW TSC Act;
533	New England Peppermint grassy woodland on granitic substrates of the New England Tablelands Bioregion	Nominated Commonweath EPBC Act;
534	New England Peppermint grassy woodland on sedimentary or basaltic substrates of the New England Tablelands Bioregion	Listed TSC Act, E: New England Peppermint (Eucalyptus nova-anglica) Woodland on Basalts and Sediments in the New England Tableland Bioregion (Equivalent); Nominated Commonweath EPBC Act;
538	Rough-barked Apple – Blakely's Red Gum open forest of the Nandewar and western New England Tablelands Bioregions	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
544	Rough-barked Apple -/+ cypress pine +/- Blakely's Red Gum riparian open forest / woodland of the Nandewar and New England Tableland Bioregions	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
547	Wild Quince – Mock Olive – Rusty Fig – Jamboto – Sweet Pittosporum dry rainforest of rocky and scree areas of the Nandewar and New England Tablelands Bioregions	Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part); Listed TSC Act, E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part);
554	Ribbon Gum – Mountain Gum – Snow Gum grassy open forest or woodland of the New England Tablelands Bioregion	Listed TSC Act, E: Ribbon Gum – Mountain Gum – Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (Part);
566	Mugga Ironbark open forest of the New England Tablelands Bioregion	Nominated NSW TSC Act;
571	Ribbon Gum – Rough-barked Apple – Yellow Box grassy woodland of the New England Tablelands and North Coast Bioregions	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
582	Sedgeland fens wetland of impeded drainage of the Nandewar and New England Tablelands Bioregions	Nominated NSW TSC Act;
589	White Box – White Cypress Pine – Silver-leaved Ironbark grassy woodland on mainly clay loam soils on hills mainly in the Nandewar Bioregion	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);

ID No	Common Name	Listed, nominated under TSC or EPBC Acts
590	White Box grassy woodland on the Inverell basalts mainly in the Nandewar Bioregion	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
599	Blakely's Red Gum – Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South and Nandewar Bioregions	Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part); Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part);
606	Mountain Gum – Ribbon Gum open forest of drainage lines of the southern New England Tablelands Bioregion	Listed TSC Act, E: Ribbon Gum – Mountain Gum – Snow Gum Grassy Forest/Woodland of the New England Tableland Bioregion (Part);
607	Montane bogs on the western fall of the New England Tablelands Bioregion	Listed TSC Act, E: Montane Peatlands and Swamps of the New England Tableland, NSW North Coast, Sydney Basin, South East Corner, South Eastern Highlands and Australian Alps Bioregions (Part);
618	White Box / Grey Box – Rough-barked Apple – red gum grassy woodland on rich soils on hills in the upper Hunter Valley	Listed TSC Act, E: White Box Yellow Box Blakely's Red Gum Woodland (Part); Listed EPBC Act, CE: White Box–Yellow Box–Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Part);
622	Grey gum – Forest Red Gum – Yellow Box grassy tall open forest on mid-slopes of the Hunter Valley – North Coast escarpment	Listed TSC Act, E: Hunter Lowland Redgum Forest in the Sydney Basin and NSW North Coast Bioregions (Part);
627	Coobah – Rusty Fig low woodland on limestone outcrops in the Tamworth – Attunga region of the Nandewar Bioregion	Listed TSC Act, E: Semi-evergreen Vine Thicket in the Brigalow Belt South and Nandewar Bioregions (Part); Listed EPBC Act, E: Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions (Part);
628	Carbeen -/+ Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	Listed TSC Act, E: Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions (Part);
629	Brigalow – Bladder Saltbush open woodland to tall open shrubland in the Come-By-Chance region, DRP and BBS Bioregions	Listed TSC Act, E: Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions (Part); Listed EPBC Act, E: Brigalow (Acacia harpophylla dominant and co-dominant) (Part);

Table 10. Number of NSWVCA plant communities with different threat categories in eight western NSW Catchment Management Authority areas and the Hunter/Central Rivers CMA.

Notes: Figures in brackets ( ) indicate the number of plant communities (of the total) that are restricted to a single CMA area. This assessment covers all of the Border Rivers/Gwydir, Namoi, Western and Lower Murray/Darling CMA areas updating the last two from Benson (2008). It covers about 70% of the communities in the Central West, Murray and Murrumbidgee CMAs, about 90% in the Lachlan CMA and only about 15% of communities in the Hunter/Central Rivers CMA. Many communities occur in more than one CMA. See Appendix B in Benson (2006) for an explanation of the threat categories.

	No. of Extant NSW Plant Communities									
	Catchment Management Authority Areas									
Threat Category Code	Border Rivers-Gwydir	Central West	Hunter-Central Rivers	Lachlan	Lower Murray-Darling	Murray	Murrumbidgee	Namoi	Western	Total
Critically Endangered	11 (4)	12 (3)	1 (1)	12 (3)	4	13 (1)	14 (1)	9 (2)	4 (1)	39 (16)
Endangered	50 (12)	32 (3)	9 (1)	26 (2)	4 (1)	18 (3)	25 (2)	46 (4)	18 (1)	100 (29)
Vulnerable	42 (14)	40 (2)	8 (2)	36 (2)	13 (4)	25 (1)	32 (2)	41 (4)	17 (1)	106 (32)
Near Threatened	56 (16)	37 (6)	18 (7)	24 (1)	19 (1)	19	25	65 (12)	49 (16)	160 (59)
Least Concern	37 (12)	59 (7)	16 (7)	39 (1)	22 (4)	23 (4)	28	62 (14)	68 (39)	180 (88)
Total	196 (58)	180 (21)	52 (18)	137 (9)	62 (10)	98 (9)	124 (5)	223 (36)	156 (58)	585 (224)

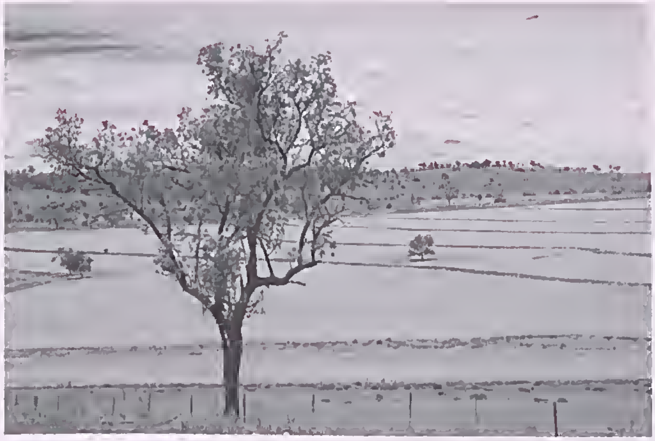

Fig. 94. Cropping of wheat on basalt hills in the Blue Knobby region with *Eucalyptus melanophlia* (Silver-leaved Ironbark) in the foreground, Munsies Road (agd66) 29° 13'20.1"S, 150° 35'52.86"E. Photographer, Jaime Plaza, 17/11/2007.

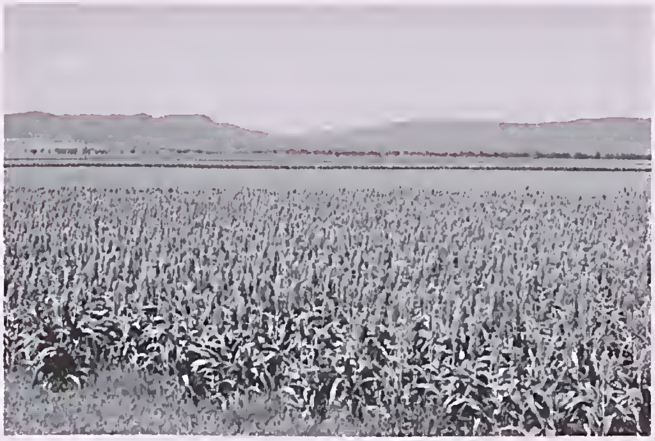

Fig. 95. Sorghum cropping on the rich alluvial soils on the Liverpool Plains south of Gunnedah. Less than 5% of the original Liverpool Plains native grassland (ID102) remain. Photograph, John Benson, 2004.

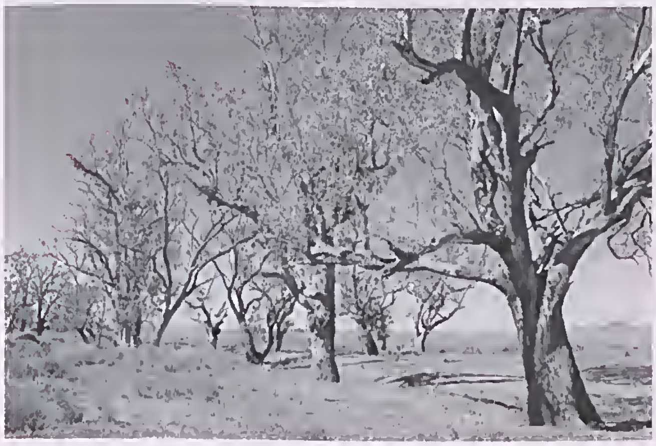

Fig. 96. ID438 Dieback in tree crowns of *Eucalyptus camaldulensis* (River Red Gum) riparian woodland along on Broken Dam Creek Black Stump Highway 5 km south of Mullaley (AGD66) 31° 7'2.4"S, 149° 53'58.1"E. Phogographer, Jaime Plaza, 6/5/09.

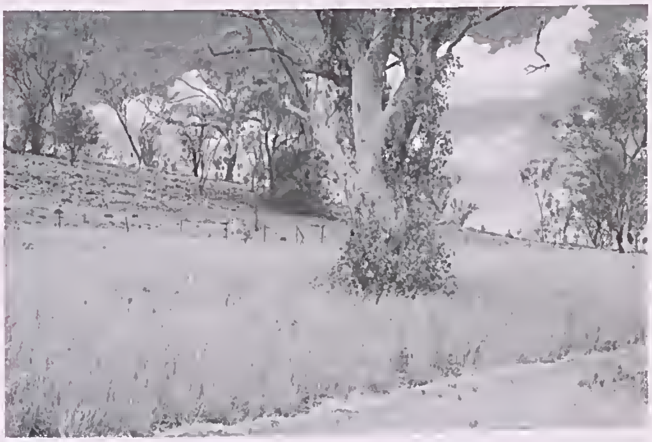

Fig. 97. Invasive introduced *Hyparrhenia hirta* (Coolatai Grass) dominating the ground cover of *Eucalyptus albens – Eucalyptus melanophloia* grassy woodland (ID589) on a basalt hill on the Yetman – Warialda Road (agd66) 29° 3'38.04"S 150° 43'35.82"E. Photographer, Jaime Plaza, 16/11/2007.

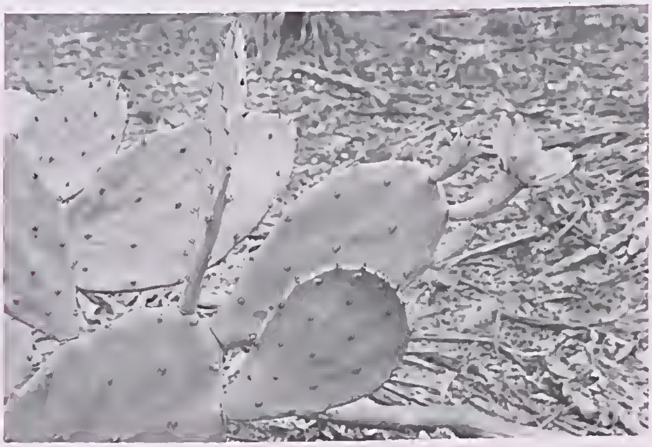

Fig. 98. *Opuntia stricta* (Prickly Pear) near Yetman. This introduced cactus invaded large areas of the NSW North-western Slopes until controlled by *Cactoblastis* insects in one the world's most successful biological control programs. Photograph, Jaime Plaza, 15/11/2007.

Management and conservation priorities

A consequence of the 2005 Western Regional Assessment forest decision by the NSW Government was that the area of conservation reserves increased three fold. New reserves focused on public lands, mainly State Forests and some Crown leasehold land. Most of these lands were on sandstone or other highly siliceous substrates containing ironbark, bloodwood, stringybark and hill red gum forests. These mainly shrubby forests and woodlands are now, in the main, reasonably well protected in conservation reserves as detailed in Table 1. In contrast, native grasslands, grassy woodlands and wetlands remain under-represented in the protected area system and in many cases they are threatened. Native grasslands are of particular concern becasue they are mainly cleared and degraded. Detailed survey, documentation and mapping of native grassland would help their protection under NSW regulations. Since "grassy" types of vegetation mainly occur on private land, gaining landholder support for conserving remnants is critical to their protection – a challenge given comparative higher prices for cropping versus stock grazing.

Travelling Stock Reserves often contain native vegetation remnants in good to reasonable condition including samples of grassy woodlands and grasslands. Examples include TSRs on the Liverpool Plains and near Moree that contain grasslands and associated grassy woodlands (IDs 102, 101, 433) (Allen & Benson in prep.) and TSRs in the west-New England Nandewar and Nandewar Bioregions (Williams & Metcalfe 1991) that contain Mugga Ironbark woodlands (IDs 527, 528, 529, 566). TSRs and roadside remnants complement the conservation reserve system and their protection from continuous grazing and alienation to freehold land is important for protecting elements of biodiversity and maintaining connectivity in agricultural landscapes (Lindenmayer *et al.* 2010). As stated above, a feature of the NSW North-western Slopes compared to the South-Western Slopes is the large extent of derived grassland in non-cropped areas – mainly in hill landscapes. These derived grasslands provide a semi-natural matrix between structurally intact native vegetation remnants and should where possible be maintained in the landscape.

Of national biological significance are the various types of dry rainforest present in the area. They include Ooline forest (Benson 1993) (IDs 113, 114), semi-arid vine thicket (IDs 147, 378, 445, 442, 452 and elements of IDs 449, 498) and dry rainforest in protected gullies or hillslopes in mountain ranges (IDs 388, 547). In total, these cover a small total extent and are vulnerable to land use change, fire, grazing from feral animals including goats and rabbits and invasion by exotic plant species. Priority should be given to protecting dry rainforest in reserves or via secure property agreements with management aimed to reducing feral animals and weeds. Key sites for rainforest protection include on basalt hills in the Blue Knobby region near Yetman, hills near Warialda and south to Bingara, on Turkey Ridge east of Narrabri, hills on the Liverpool Plains and on the southern slopes of the Liverpool Range.

Some riparian woodlands and forests link natural remnants across agricultural lands and contain tree species that occur on higher nutrient soils which in turn may be important as a resource for some species of fauna. For example, we observed Little Red Flying Foxes roosting in *Callistemon viminalis* riparian low forest (ID362) on basalt soils near Warialda.

Wetlands are another vegetation formation that are poorly protected and under threat. This includes sedgeland wetlands occurring across all three bioregions (BBS, NAN and west-NET) in impeded creeks or valleys (IDs 447, 465, 497, 582, 586); montane lakes on the New England (ID500); sodic outwash plains wetlands near Yetman (ID363, 364) and the unusual "tank gilgai" wetlands containing the critically endangered waterplant *Myriophyllum implicatum* in the north-west Pilliga forests and adjoining private land.

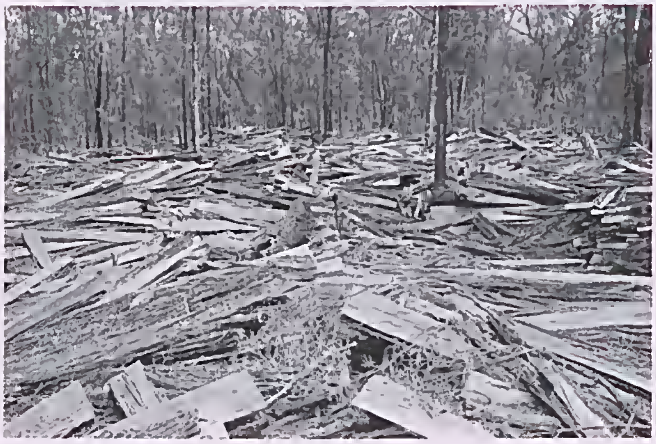

Fig. 99. Sawn log off-cuts dump site in *Eucalyptus crebra – Allocasuarina luehmannii – Callitris glaucophylla* open forest (ID373) in the former Bebo State Forest now Dthinna Dthinnawan National Park, near Yetman (agd66) 28° 48'3.42"S 150° 54'9.78"E. Jaime Plaza, 15/11/2007.

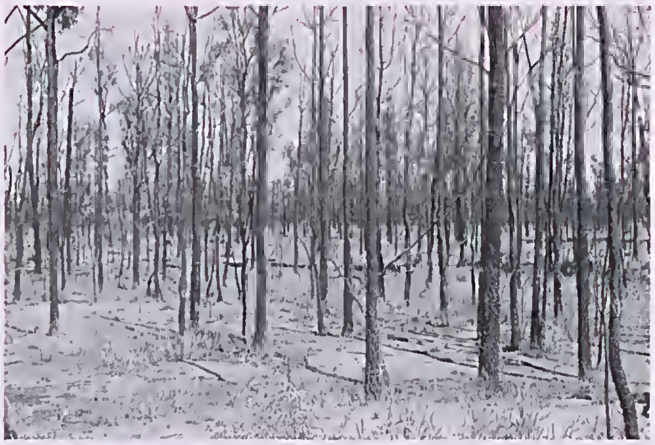

Fig. 100. Intensely burnt (in 2006) *Eucalyptus crebra – Allocasuarina luehmannii* forest (ID398) in the Pilliga Scrub on the Newell Highway, north of Coonabarabran (agd66) 30° 39'4.5"S 149° 33'27.78"E. Photographer, Jaime Plaza, 13/11/2007.

Changes to NSW Western Plains and South-western Slopes Bioregion plant communities in NSWVCA Version 3

One of the challenges of the NSWVCA database system is keeping track of new literature and changes in the NSW protected area system. Many minor changes, such as typographical errors or species name changes, have been made to the 320 NSW Western Plains and NSW South-western Slopes plant communities published in the 2008 Version 2 of the NSWVCA database (Benson 2008). Other changes are due to user feedback and the addition of new conservation reserves. Major changes are kept in a register spreadsheet on the Royal Botanic Gardens Sydney web site at: http://www.rbgsyd.nsw.gov.au/science/Evolutionary_Ecology_Research/vegetation_of_nsw.

A total of 226 plant communities are now listed for the Western Plains section of NSW. These include two newly described plant communities that were not published in version 2 of the NSWVCA database in Benson (2008). These are:

ID630 "Black Box – Silver Saltbush chenopod open woodland on terrace rises on alluvial plains in the lower Darling River and lower Murray River region of the Murray-Darling Depression Bioregion"; and

ID631 "White Cypress Pine – Western Rosewood – spinifex grass open woodland on sand-dunes in the Murray-Darling Depression Bioregion".

Both of these arid zone communities occurring in far south-western NSW and both are derived from new data recorded as part of environmental impact assessments that used the NSWVCA as the basis for assessment (I. Sluiter pers. comm.).

A total of 146 plant communities are now recorded for the NSW South-western Slopes Bioregion, an increase of 11 from version 2 in Benson (2008). The 11 additional communities include two newly described communities confined to the NSW SWS Bioregion. These are:

ID426 "Red Box – White Box +/- Red Stringybark hill woodland in the NSW South-western Slopes Bioregion";

ID633 "Speargrass – Redleg Grass derived grassland on hills in the Jindera to Holbrook region, southern South-western Slopes Bioregion"

The other eight communities: IDs 412, 435, 461, 464, 476, 477, 478 and 479 mainly occur in the BBS Bioregion but overlap into the northern part of the NSWSWS Bioregion between Merriwa, Gulgong and south of Dubbo. Recent changes to the IBRA Bioregional boundaries added part of the Capertee Valley in the western Blue Mountains region to the NSW South-western Slopes Bioregion. This will lead to further additions to the list of plant communities in the NSW SWS Bioregion.

Revisions to the distribution of plant communities since Version 2 have resulted in a limited number of plant communities being added to previous lists of occurrence in the Western, Lower Murray Darling, Murray, Murrumbidgee, Lachlan and Central West CMAs. It is important that the PVP Biometric tool used in NSW vegetation regulations is regularly updated with these changes so that CMA property planning decisions and other environmental assessments are based on the latest information in the NSWVCA.

A number of new conservation reserves in western NSW have required changes to the database to include statistics on areas of plant communities in these protected areas. These include the 90 000 hectare Toorale National Park near Bourke that is split between the Darling Riverine Plains and Mulga Lands Bioregions; Barwon Nature Reserve, Ginghet Nature Reserve and Gwydir Wetlands State Conservation Area in the Darling Riverine Plains Bioregion.

Revised reports generated from Version 3 of the NSWVCA database for each of the eight bioregions and the two western-most CMAs in the NSW Western Plains Section and the NSW South-western Slopes Bioregion are provided on the DVD.

New River Red Gum reserves in the Riverina Bioregion

At the time of writing, approximately 107 000 ha of reserves were dedicated to protect River Red Gum forest and other floodplain vegetation types mainly in the NSW Riverina Bioregion. This includes dedication of new reserves over previous State forests or other lands; amalgamation of several existing reserves into these new reserves; and changes to the names of some existing reserves. Given the complexity of these reserve changes, reviewing the protected area status of plant communities in them will take considerbale effort. Also, a vegetation map of the new reserves may be drafted and this would inform protected area statistics Once the new River Red Gum forest reserves are taken into account, the proportion of extent in protected areas of some Riverina Bioregion floodplain plant communities will increase thereby changing their NSWVCA protected area codes This will particualrly effect the River Red Gum forests and woodlands IDs 2, 5, 7, 9, 10 and 11; Black Box woodland ID13; Lignum ID17; riverine open areas (ID12); sandhill cypress pine and Buloke woodland (ID19, 20) and some chenopod shrubland communities. If and when a review is completed on the NSWVCA plant communities in the River Red Gum reserves, the changes will be documented either in a supplementary short communication in this journal or posted on the NSWVCA BGT web site.

Future progress of and improvements to the NSWVCA

As mentioned in the Introduction, the NSWVCA has covered 11.5 of the 18 IBRA Bioregions (Thackway & Cresswell 1995, Version 6.1) in NSW. The vegetation in the South East Highlands and Australian Alps Bioregions (encompassing the NSW Southern Tablelands Botanic Division) is required to complete the NSWVCA for four south-western CMA areas: Murray, Murrumbidgee, Lachlan and Central West. It is anticipated this would include over 200 new plant communities in a region of over five million hectares. The next logical stage is to complete the eastern half of the New England Bioregion and link this to coverage of the NSW North Coast that includes the southern part of the South East Queensland Bioregion and the entire NSW North Coast Bioregion. This would complete the complex north east corner of NSW. Subsequent work would involve covering the Sydney Basin Bioregion and the South East Corner Bioregion. Due to the biological complexity of the NSW eastern escarpment and coast, completing the NSWVCA in that Section will require the analysis of available abundant plot data in combination with expert workshops to fill data gaps. It would also require a number of people entering data into the NSWVCA database in a coordinated manner.

Preparations for the NSW coastal classification have commenced. For example, Somerville (2009) and Eco Logical Australia (2009) have completed a vegetation classification for the Hunter-Central Rivers CMA area. DECCW Metropolitan Division is finalising over a decade of work in surveying and mapping, at fine resolution, most of the Sydney Basin Bioregion, including conservation reserves (D. Connelly pers. comm.). There has been re-analysis of plot data producing a vegetation classification along with the production of modelled 1:100 000 scale maps covering NSW South Coast (Tozer et al. 2010). A classification of 52 North Coast heath communities has been completed and is ready for data entry into the NSWVCA database (SGriffiths pers. comm.) and expert workshops have been held on developing a vegetation classification for the entire NSW North Coast and east New England regions.

The coastal Section could be completed concurrently with completing the NSW Tablelands Section eventually merging the results to complete a single database vegetation classification covering all 80 million hectares of NSW. This would take 3–5 years depending on the level of resources put to it. The final NSW classification is likely to describe 1400 –1600 plant communities. This could be expanded to include communities based on marine algae or freshwater algae if they can be defined.

With feedback to published versions of the NSWVCA database improvements are made to the plant community records including species assemblages, estimates of extent, vegetation description and other factors. Version 3 presented here could be improved with the addition of images of some NAN and NET plant communities that currently lack photographs and with the completion of the State Landscape (Mitchell 2002) correlation field. There is also the need for a more comprehensive review of vegetation types in secure property agreements particularly permanent (99 year) property agreements (PVPs) under the NSW *Native Vegetation Act* 2003 and caveats on private land under the NSW *Land Conservation Trust Act* 2001. Some areas of native vegetation protected under property vegetation plans (PVPs) under the *Native Vegetation Act* 2003 are not recorded in the NSWVCA database because the data are difficult to access from current property agreement databases. It would be beneficial if these databases were integrated with other protected area databases in NSW

As with previous versions of the NSWVCA new plant communities are likely to be added with new data and reinterpretation of existing data. Conversely, arguments may be put that communities be amalgamated.

Since version 2 was published (Benson 2008), a trial SQL version mirroring the NSWVCA MS Access database has been developed by the NSW Department of Environment, Climate Change and Water. When this is developed to an acceptable standard it will provide internet access to view and generate a range of standard and dynamic reports from the database. The dynamic report option will allow for the selection plant communities using combinations of database fields.

Future modifications to the NSWVCA database could include:

Adding a "sample plot reference" field that lists typical plot data that help to define and describe the plant community. This could link directly to the DECC NSW floristic plot (site) data database;

Adding a separate species field that lists species with positive fidelity to a plant community derived through analyses of plot data. This would enhance the vegetation description;

Link the species listed in the NSWVCA database characteristic species fields to the NSW National Herbarium Botanic Gardens Trust species database EMU and its internet derivative BGT PlantNet species information system (http://www.rbgsyd.nsw.gov.au/plant_info/Plant_databases). This would allow access to taxonomic information and images of community characteristic plant species;

To increase geo-referencing in the NSWVCA database, citations of vegetation maps entered in the Authority database field could be hot-linked to image or GIS files of relevant vegetation maps. These maps may or may not cover the total extent of a community or be defined at the same level of classification as the NSWVCA;

Add pre-European and Current Extent fields for 13 CMA areas that allow separate recordings on extent for each CMA area where a plant community extends across multiple CMAs.

Improve visual representation of the landscape position of the plant communities by inserting an extra database field that contains "reference" latitude and longitudes that can automatically link to Google Earth, Google Maps or NSW Government satellite imagery. This would provide a "sky view" of some areas of each plant community via remote sensing technology;

To improve the relationship with the NSW Biometric Tool used in property planning (Gibbons *et al.* 2005) (http://www.nationalparks.nsw.gov.au/npws.nsf/Content/biometric_tool), the vegetation structure section of the database could expand to include more vegetation strata to cater for the more complex structure of eastern NSW forests. Database fields on other aspects of vegetation structure such as benchmarking number of logs on the ground, average number of tree hollows, average stem density, could also be added.

It is planned that a stand alone version of the NSWVCA database will be published occasionally for use on personal computers, field laptops or where internet connection to the SQL version is unavailable or of poor quality. An advantage of a stand alone version is that large PDF reports can be produced locally saving the need to download them over the internet.

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References

Note: A bibliography of all references used in the classification and assessment of the vegetation of the eight bioregions that comprise the previously published NSW Western Plains (Benson *et al.* 2006), the NSW South-western Slopes Bioregion (Benson 2008) and the Brigalow Belt South and Nandewar Bioregions and the western section of the New England Bioregion (covered in this paper) is presented in the spreadsheet file *NSWVCA Version 3 Bibliography.xls* on the DVD in the back pocket of this journal. The references listed below are those cited in this paper.

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Erratum

Table 1 in Benson (2008) covering the plant communities in the NSW South-western Slopes Bioregion contained an error in the *Protected Range (% pre-European)* statistic in the third column of Table 1 on page 608. A spreadsheet containing protected area data covering all plant communities in Version 3 of the NSWVCA database is provided on the DVD and will be posted on the BGT web site.

Appendix A. ID405: Full report (90 fields) of a widely distributed shrubby bloodwood – ironbark woodland in the Pilliga forests in the BBS Bioregion that is mainly intact, in good condition and assessed as being of Least Concern. Fire intensity and frequency is the main management issue.

Veg. Comm. ID No.	405
Common Name	**White Bloodwood – Red Ironbark – cypress pine shrubby sandstone woodland of the Pilliga Scrub and surrounding regions**
Scientific Name	*Corymbia trachyphloia subsp. amphistomatica – Eucalyptus fibrosa – Callitris endlicheri – Eucalyptus crebra / Persoonia sericea – Hibbertia obtusifolia – Grevillea floribunda – Xanthorrhoea acaulis / Pomax umbellata – Aristida jerichoensis var. subspinulifera – Digitaria breviglumis – Schoenus ericetorum*
Original Data Entry	J.S. Benson
Original Data Entry Date	19/02/2009
Last Modified By	NA
Last Modified Date	NA
Formation Group	Eucalyptus Corymbia (Mostly Shrubby) Woodlands and Forests on Low Fertility Soils on the Western Slopes
State Veg Map (Keith 2004)	Western Slopes Dry Sclerophyll Forests;
State Landscapes (Mitchell 2002)	Not correlated
NVIS Major Veg Sub-Groups	Eucalyptus woodlands with a shrubby understorey;
Forest Type (RN 17)	209 – Brown Bloodwood – Ironbark/Red Gum (P);
Characteristic Trees	*Corymbia trachyphloia subsp. amphistomatica; Eucalyptus fibrosa; Callitris endlicheri; Eucalyptus dwyeri; Eucalyptus crebra; Callitris glaucophylla; Eucalyptus chloroclada; Eucalyptus macrorhyncha*
Characteristic Shrubs/Vines/ Epiphytes	*Persoonia sericea; Hibbertia obtusifolia; Grevillea floribunda; Xanthorrhoea acaulis; Calytrix tetragona; Cassinia arcuata; Acacia mariae; Allocasuarina diminuta subsp. diminuta; Homoranthus flavescens; Acacia pilligarensis; Melichrus urceolatus; Brachyloma daphnoides subsp. daphnoides; Pimelea linifolia; Boronia glabra; Macrozamia heteromera; Dillwynia sericea; Acacia gladiiformis; Zieria aspalathoides; Cryptandra amara var. floribunda; Dodonaea viscosa* subsp. *spatulata; Olearia microphylla; Astrotricha longifolia inland form; Styphelia triflora; Acacia flexifolia; Acacia pravifolia; Acrotriche rigida; Ricinocarpos bowmanii; Cassinia laevis; Pultenaea boormanii; Isopogon petiolaris; Acacia cultriformis; Persoonia curvifolia; Cassytha pubescens; Leptospermum parvifolium; Dodonaea peduncularis; Acacia penninervis* var. *penninervis; Acacia caroleae; Aotus mollis; Hibbertia covenyana; Acacia polybotrya; Pultenaea cinerascens; Prostanthera howelliae; Leucopogon muticus; Pultenaea cinerascens; Grevillea triternata; Hovea apiculata; Dodonaea falcata; Ozothamnus diosmifolius; Daviesia pubigera; Acacia pilligaensis*
Characteristic Groundcover	*Pomax umbellata; Aristida jerichoensis* var. *subspinulifera; Digitaria breviglumis; Lomandra filiformis* subsp. *coriacea; Schoenus ericetorum; Dianella revoluta var. revoluta; Platysace ericoides; Goodenia hederacea* subsp. *hederacea; Lomandra leucocephala* subsp. *leucocephala; Opercularia diphylla; Lepidosperma laterale; Oxalis radicosa; Hardenbergia violacea; Dampiera adpressa; Chloanthes parviflora; Dampiera lanceolata* var. *lanceolata; Gonocarpus elatus; Actinotus helianthi; Poranthera microphylla; Panicum simile; Chrysocephalum semipapposum; Wahlenbergia communis; Helichrysum collinum; Hybanthus monopetalus; Goodenia heteromera; Tricoryne elatior; Stackhousia muricata; Thysanotus tuberosus* subsp. *tuberosus; Coronidium oxylepis* subsp. *lanatum; Chloanthes parviflora; Panicum effusum; Goodenia hederacea subsp. hederacea; Wahlenbergia gracilis; Aristida benthamii* var. *benthamii*
Characteristic Weed Species	*Hypochaeris glabra*
Weediness	Low (<5%) with <10 % cover
Threatened Plants	*Hibbertia covenyana* (restricted)
Threatened Fauna	Not assessed
Mean Native Species Richness	41 (20 x 20 m plots in FG 153 in RACAC 2004)
Characteristic Qualifiers	(Quantitative Data)
Authority(s)	Includes Floristic Groups 151, 152 and 153 in RACAC (2004). Probably includes the Heathy Bloodwood Ironbark (2) floristic group in Binns & Beekers (2001). Probably part of tree group 19 and most of full floristic group 3 in Binns *et al.* (1999). Stop 8 in trip 1, stops 53, 56 and 62 in trip 7, stop 63 trip 14 in Benson (1999–2009).
Authority Qualifiers	(Quantitative Data)
Interstate Equivalent(s)	None

Class. Confidence Level	Medium
Level of Classification	Association
Rainforest Structure (Webb)	Not applicable
Structure (WH)	Woodland
Height Class (WH)	Mid – High; Tall;
Vegetation Description	Mid – high to tall woodland dominated by Red Ironbark (*Eucalyptus fibrosa*), White Bloodwood (*Corymbia trachyphloia*) and Black Cypress Pine (*Callitris endlicheri*). Other tree species may include White Cypress pine (*Callitris glaucophylla*), *Eucalyptus crebra*, *Eucalyptus macrorhyncha* and *Eucalyptus chloroclada*. The shrub layer is highly diverse with a mid-dense density but it may be dense in places or sparse after fire. Shrub species include *Persoonia sericea, Hibbertia obtusifolia, Grevillea floribunda, Xanthorrhoea acaulis, Calytrix tetragona, Cassinia arcuata, Acacia mariae, Allocasuarina diminuta* subsp. *diminuta, Homoranthus flavescens, Cryptandra amara* var. *floribunda, Acacia pilligaensis. Melichrus urceolatus, Brachyloma daphnoides* subsp. *daphnoides, Pimelea linifolia, Boronia glabra, Macrozamia heteromera, Dillwynia sericea, Acacia gladiiformis, Zieria aspalathoides, Leptospermum parvifolium, Styphelia triflora* and *Dodonaea peduncularis*. The ground cover may be sparse under a dense shrub layer or very sparse after fire. Grass species include *Aristida jerichoensis, Digitaria breviglumis* and *Panicum simile*. Mat-rushes include *Lomandra leucocephala* subsp. *leucocephala* and *Lomandra filiformis* subsp. *coriacea*. The sedge *Schoenus ericetorum* is often abundant. Forb species include *Pomax umbellata, Dampiera adpressa, Dianella revoluta* var. *revoluta, Platysace ericoides, Goodenia hederacea subsp. hederacea, Chloanthes parviflora, Dampiera lanceolata* var. *lanceolata, Gonocarpus elatus, Actinotus helianthi, Poranthera microphylla, Chrysocephalum semipapposum, Wahlenbergia communis, Goodenia heteromera, Tricoryne elatior and Thysanotus tuberosus* subsp. *tuberosus*. Weeds are in low abundance but the floristic variation of the understorey varies greatly with time since fire and the intensity of fire. Occurs on yellow to orange loamy sand soils that may be texture constrast (solodized solonetz) derived from sandstone on hillslopes, hillcrests in low hill landform patterns mainly in the central part of the Pilliga Scrub forests with outliers to the north and south. Mainly uncleared but subject to occasional intense wildfire that alters floristic composition and vegetation structure – with successional stages of recovery containing changing species assemblages or dominance. Not threatened and well represented in Pilliga Scrub reserves.
Mapped/Modelled	Current extent partly mapped
Mapping Info	Mapped as some of Red Ironbark – Bloodwood Lindsay (1967) types in Pilliga forests.
Adequacy Of Plot Sampling	Adequate
Climate Zone	Dry subtropical: moderately dry winter; Temperate: no dry season (hot summer);
IBRA Bioregion (v6)	Brigalow Belt South (>70%);
IBRA Sub-Region	Pilliga subregion (>70%);
Botanical Division	North Western Slopes (NWS) (30–70%); North Western Plains (NWP) (30–70%);
Local Govt. Areas	Gilgandra (1–30%); Warrumbungle (30–70%); Narrabri (30–70%);
CMAs	Namoi (>70%); Central West (1–30%);
MD Basin	Yes
Substrate Mass	Sedimentary rocks;
Lithology	Ferruginous sandstone; Sandstone;
Great Soil Group	Solodized solonetz;
Soil Texture	Loamy sand;
Landform Patterns	Low hills;
Landform Elements	Hillcrest; Hillslope;
Land Use	Nature Conservation; Timber Production;
Impacts of Euro. Settlement	No significant impacts known;
Pre-European Extent (ha)	140000
Pre-European Accuracy (%)	10
Pre-European Qualifiers	Modelled from sound site or polygon data
Pre-European Comments	Reduced from estimated from modelled FGs 151, 152 and 153 in RACAC (2004)
Current Extent (ha)	120000
Current Extent Accuracy (%)	10
Current Extent Qualifiers	Modelled from sound site data over unclassified map of extant vegetation
Current Extent Information	Estimated from modelled FGs 151, 152 ansd 153 in RACAC (2004). Very little has been cleared. Some logging and wildfire impacts.
Percent Remaining	86
% Remaining Accuracy	±30
Degree of Fragmentation	Contiguous stands with high connectivity with >60% extent remaining and low edge to area ratio
Recoverability	Healthy, structure and composition intact. Insignificant indicators of degradation. Likely to continue in good health if maintained.

Threatening Processes	Increased intrense wildfire coulod imapct on this community. Too-frequent burning could reduce populations of some shrub sepcies. Feral animals (goats and pigs) browse and graze some areas.
Threat Process List	Age class of woody vegetation; Climate change; Forestry activities including logging; Inappropriate fire regimes; Soil erosion, water: sheet erosion; Unsustainable grazing by introduced animals;
Variation and Natural Disturbance	Variation over range, including due to differences in fire patterns.
Adjoining Communities	Floristically similar to Pilliga Red Ironbark woodland (ID404) and White Bloodwood – Curacabah woodland (ID406).
Fire Regime	Natural wildfire frequency 20–80 years. The survival of some obligate-seeder shrub species may be adversely affected if they are burnt too regularly.
Conservation Reserves	Timallallie CCAZ1 16820 (E3); Pilliga East CCAZ3 11460 (E3); Pilliga NR 35000 (E3); Pilliga East CCAZ2 60 (E2); Pilliga CCAZ3 500 (E2); Dandry Gorge CCAZ2 215 (E3); Lanes Mill FR 34 (E4); Yarragin CCAZ1 150 (E3); Burral Yurrul CCAZ1 8 (E3); Goonoo CCAZ3 200 (E4);
Total Area in Reserves (ha)	64447
No. of Reps in Reserves	10
Explanation of Protected Areas	Timallallie CCAZ1 estimated from Lindsay (1967) White Bloodwood – ironbark types. Pilliga East AA, Pilliga East SCA, Pilliga NR, Dandry Gorge CCAZ2 (AA), Lanes Mill Flora, Yarragin CCAZ1 (NP), Burral yurrul CCAZ1 reserve estimates from floristic groups 151, 152, 153 in RACAC (2004) or TB, PTB Lindsay (1967) types. Pilliga CCAZ3 from bloodwood forest types in Lindsay and FG groups 152, 153 in RACAC (2004). Goonoo CCAZ3 from White bloodwood forest type and modelled FG 152 in RACAC (2004).
Secure Property Agreements	None
Total Area in Secure PAs	0
No. of Reps in Secure PAs	0
Total Area Protected (ha)	64447
Area Protected Accuracy %	30
Protected Pre-Euro. Extent %	46.03
Protected Current Extent %	53.7
Total Reps in Protected Area	10
Common (>10000 ha 1750)	1a: >25% in protected areas
Common Qualifiers	Adequately across distribution
Key Sites for Protection	Well sampled in a number of Pilliga conservation reserves with large areas also in Pilliga East State Forest.
Threat Category	Least Concern
Threat/Protected Area Code	LC/1a
Threat Criteria	1; 4; 5;
Planning and Management	Manage prescribed burning and wildfire to maintain species composition.
Listed Under Legislation	None;
Recovery Plan (Yes)	0
Recovery Plan	not required
Photo1	ID405a_BBSMar09_1133.jpg

Photo Caption 1 ID405 *Corymbia trachyphloia – Eucalyptus fibrosa – Callitris endlicheri* shrubby woodland on a hillcrest in Galloway Fire Trail in Pilliga Nature Reserve (AGD66) 30°50' 20.8"S 149°38' 25.4"E. Photographer, Jaime Plaza, 21/3/09.

Photo 2

ID405b_BBSSept06_1162.jpg

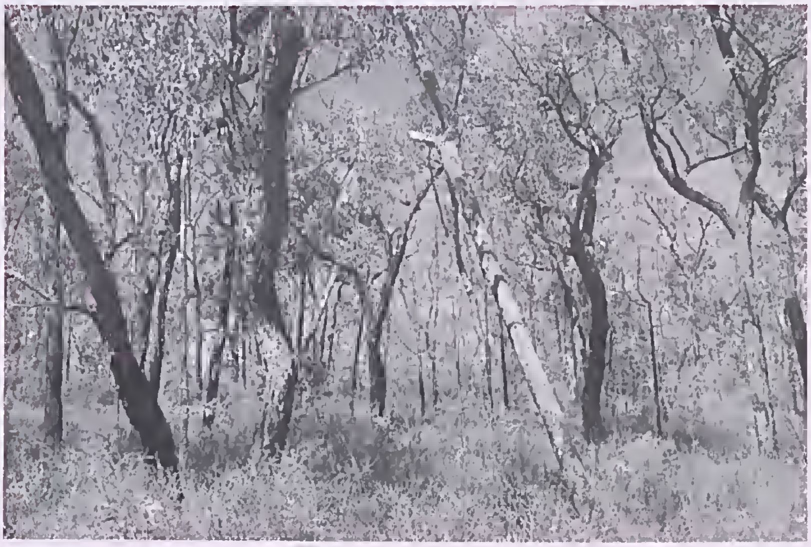

Photo Caption 2

ID405 *Corymbia trachyphloia – Eucalyptus fibrosa – Callitris endlicheri* shrubby woodland Banksia Fire Trail Pilliga NR (AGD66) 31°0' 19.4"S, 149°19' 7"E. Photographer, Jaime Plaza, 18/09/06.

Photo 3

ID405c_BBSMar09_0895.jpg

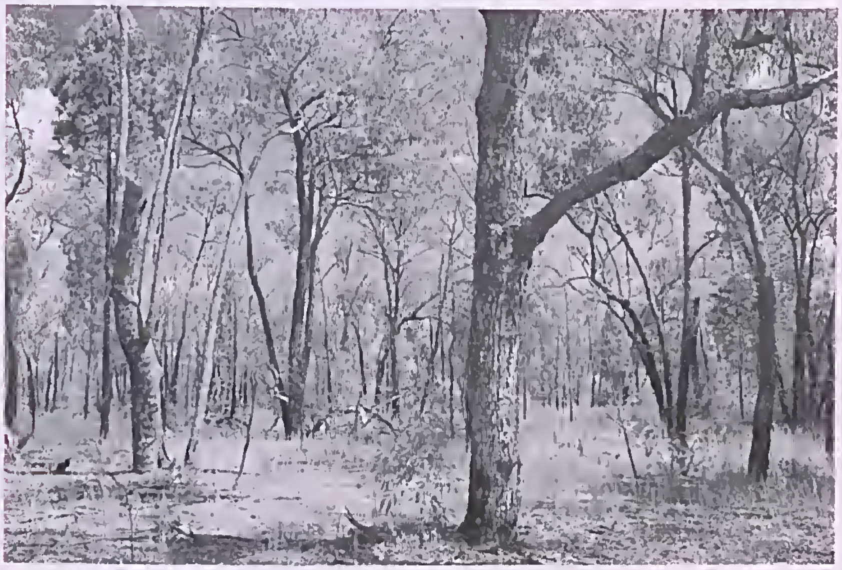

Photo Caption 3

ID405 *Corymbia trachyphloia – Eucalyptus fibrosa – Callitris endlicheri* shrubby woodland on orange loamy sand on Tap Crossing Road in Timallaille National Park (AGD66) 30°58' 39.7"S 149°13' 32.2"E. Photographer, Jaime Plaza, 20/3/09.

Reference List

308; 184; 182; 335; 185;

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Appendix B. ID102: Full report (90 fields) of a native grassland that was originally extensive but is now almost entirely cleared, highly fragmented and is assessed as being Critically Endangered.

Veg. Comm. ID No.	102
Common Name	**Liverpool Plains grassland mainly on basalt-derived black earth soils, Brigalow Belt South Bioregion**
Scientific Name	*Austrostipa aristiglumis – Dichanthium sericeum subsp. sericeum – Panicum decompositum var. tenuius – Enteropogon acicularis – Austrodanthonia bipartita – Sida spinosa / Oxalis perennans – Boerhavia dominii – Tribulus micrococcus – Asperula conferta – Cyperus bifax – Sida trichopoda*
Original Data Entry	J.S Benson
Original Data Entry Date	31/12/2005
Last Modified By	Chris Allen
Last Modified Date	27/04/2010
Formation Group	Grasslands on Fine Texture Soils on the Inland Slopes and Plains
State Veg Map (Keith 2004)	Western Slopes Grasslands;
State Landscapes (Mitchell 2002)	Not correlated
NVIS Major Veg Sub-Groups	Blue grass (*Dichanthium*) and tall bunch grass (*Chrysopogon*) tussock grasslands;
Forest Type (RN 17)	230 – Natural Grassland (P);
Characteristic Trees	Generally no trees in the grassland; *Eucalyptus populnea* subsp. *bimbil; Eucalyptus albens*
Characteristic Shrubs/Vines/ Epiphytes	Generally no shrubs or vines in the grassland: grades into *Acacia pendula; Alectryon oleifolius* subsp. *elongatus*
Characteristic Groundcover	*Austrostipa aristiglumis; Dichanthium sericeum* subsp. *sericeum; Panicum decompositum; Enteropogon acicularis; Oxalis perennans; Boerhavia dominii; Austrodanthonia bipartita; Tribulus micrococcus; Asperula conferta; Cyperus bifax; Sida trichopoda; Sida spinosa; Carex inversa; Marsilea drummondii; Solanum esuriale; Aristida personata; Vittadinia pterochaeta; Sclerolaena muricata var. semiglabra; Convolvulus gramineteus; Aristida leptopoda; Portulaca oleracea; Chamaesyce drummondii; Cullen tenax; Leiocarpa panaetioides; Neptunia gracilis* f. *gracilis*
Characteristic Weed Species	*Rapistrum rugosum; Medicago polymorpha; Lolium rigidum; Sonchus oleraceus; Urochloa panicoides; Silybum marianum; Ammi majus; Lepidium africanum; Carthamus lanatus; Avena fatua; Medicago minima*
Weediness	High (15–30%) with 10–30% cover
Threatened Plants	None recorded
Threatened Fauna	Two rare endemic land snails are recorded in the grassland: *Camaenidae* NE4; *Camaenidae* NE25
Mean Native Species Richness	Varies with seasons and with rainfall. About 30±5 in wet years in 10x10 m plots (Botanic Gardens Trust plot data); about 6 species per plot in severe drought;
Characteristic Qualifiers	(Quantitative Data)
Authority(s)	Part of floristic group 191 in RACAC (2004). Similar to floristic group 23 in Cannon *et al.* (2003). Soil Conservation Service of NSW (1970?). Duggin & Alison (1984) and Sim & Unwin (1983) document the Liverpool Plains grasslands spatially using aerial photos and ground traverse. Hosking (2001) lists over 100 species from the Liverpool Plains. Lang (2008) maps original extent of treeless grasslands. Part of Plains Grass alliance in section 20.5.3.7.2 in Beadle (1981). The main Liverpool Plains floristic group defined in Allen & Benson (2010). Field checked and some species listed at stop 41 trip 14 Benson (1999–2009). Contains some similarities with Moree grasslands on black soils (ID52) and Inverell basalt grasslands (ID590).
Authority Qualifiers	(Quantitative Data)
Interstate Equivalent(s)	Queensland: May be similar to regional ecossytem 11.3.24 (Themeda avenacea) on basalt and RE 11.3.21;
Class. Confidence Level	High
Level of Classification	Association
Rainforest Structure (Webb)	Not applicable
Structure (WH)	Closed Grassland; Grassland; Open Grassland; Sparse Grassland;
Height Class (WH)	Tall; Very Tall;

Vegetation Description	Tall tussock closed or open grassland dominated by Plains Grass (*Austrostipa aristiglumis*), wallaby grass (*Austrodanthonia bipartita*), *Panicum decompositum*, *Eriochloa* spp., *Themeda avenacea*, Queensland Blue Grass (*Dichanthium sericeum*), *Aristida leptopoda*, *Chloris truncata*, *Enteropogon acicularis*, *Astrebla elymoides* and *Digitaria divaricatissima*. Forbs and climbers include *Vittadinia pterochaeta*, *Cullen tenax*, *Oxalis perennans*, *Boerhavia dominii*, *Tribulus micrococcus*, *Asperula conferta*, *Rhynchosia minima*, *Podolepis muelleri* and *Wahlenbergia communis*. Climbers include *Glycine latifolia* and *Convolvulus graminetus*. The most abundant sedge is *Cyperus bifax* while species of *Juncus* occur in wet places. Roly Poly (*Sclerolaena muricata*) and *Leiocarpa panaetioides* are common small shrubs. Grades into areas with scattered tall shrubs or small trees including Myall (*Acacia pendula*), Western Rosewood (*Alectryon oleifolius* subsp. *canescens*) and Wild Orange (*Capparis mitchellii*). The true treeless grasslands were probably restricted to very flat mainly black loam to clay soil country with a slope less than half a degree. Weeds include *Ammi majus*, *Rapistrum rugosum*, *Lactuca serriola*, *Lactuca saligna*, *Rumex tenax* and *Aster subulatus*. Occurs on deep, black alluvial cracking clay-loam (black earths) soils derived from basalt on plains and alluvial plains. Distributed north from Quirindi to Boggabri in the Liverpool Plains sub-region in the Brigalow Belt South Bioregion. Grades into a similar type of grassland (ID52) around Moree but the Liverpool Plains community contains a different suite of species with less Mitchell Grass (*Astrebla*) and is mostly dominated by Plains Grass (*Austrostipa aristiglumis*). Grades into various grassy box open woodlands on slightly sloping land where tree species include Yellow Box (*Eucalyptus melliodora*), Poplar Box (*Eucalyptus populnea* subsp. *bimbil*), White Box (*Eucalyptus albens*), Fuzzy Box (*Eucalyptus conica*) and *Angophora floribunda*. Similar grassland to the Liverpool Plains often occurs under these trees although areas with redder soils derived from sedimentary substrates contain more *Aristida personata*. Most of the Liverpool Plains grassland has been ploughed for crops including wheat, cotton and sorghum. A critically endangered community with less than 5% remaining and threatened by further cropping, fragmentation, weed invasion, coal mining and salinity. Listed as part of an Endangered EEC in both the TSC and EPBC Acts.
Mapped/Modelled	Current extent partly mapped
Mapping Info	The Liverpool Plains grasslands have been sampled four times in 87 10 x 10 m plots reported in Allen & Benson (2010). Original treeless grassland area mapped by Lang (2008). Some key Liverpool Plains sites mapped in 1984 (Duggin & Alison 1984 and Sim & Unwin 1883) but some have been since cleared. Pre-European extent mapped around Quirindi by SCS (1970?). Part of map unit 3g in Cannon *et al.* (2002).
Adequacy Of Plot Sampling	Adequate
Climate Zone	Temperate: no dry season (hot summer);
IBRA Bioregion (v6)	Brigalow Belt South (>70%); Nandewar (1–30%);
IBRA Sub-Region	Liverpool Plains (>70%); Northern Basalts (1–30%); Peel (1–30%);
Botanical Division	North Western Plains (NWP) (1–30%); North Western Slopes (NWS) (>70%);
Local Govt. Areas	Gunnedah (30–70%); Liverpool Plains (30–70%); Moree Plains (1–30%); Narrabri (1–30%); Warrumbungle (1–30%);
CMAs	Border Rivers-Gwydir (1–30%); Namoi (>70%);
MD Basin	Yes
Substrate Mass	Alluvium; Lacustrine sediment;
Lithology	Alluvial loams and clays; Basalt; Clay;
Great Soil Group	Black earth; Chernozem; Chocolate soil; Krasozem;
Soil Texture	Clay loam; Light clay; Light medium clay; Loam;
Landform Patterns	Alluvial plain; Plain;
Landform Elements	Plain;
Land Use	Cropping and Horticulture; Grazing;
Impacts of Euro. Settlement	Major alteration of understorey; Major reduction (>70%) in extent and /or range; Major alteration by drainage channels;
Pre-European Extent (ha)	280000
Pre-European Accuracy (%)	10
Pre-European Qualifiers	Estimated from pre-European map: part range
Pre-European Comments	The Liverpool Plains sub-region is over 700 000 in size and originally contained various woodlands, open forests and native grasslands. Lang (2008) mapped 280 000 ha as the original treeless grassland. Sim & Unwin (1983) estimated that about 250 000 ha was black alluvial plains on which grassland dominated.
Current Extent (ha)	8000
Current Extent Accuracy (%)	10
Current Extent Qualifiers	Estimated from mapped extant vegetation: part range
Current Extent Information	Estimated from ground traverses and map notes by C. Allen pers. comm. Approximately 95% of the original grassland has been cleared with small remnants left on roadsides, in TSRs and in some paddock on private land (Allen & Benson 2010). Very little of this grassland remains unploughed on flat areas. A tiny fraction is "good" condition – i.e. lightly grazed. Includes part of the map unit 3g area in Cannon *et al.* (2002).

Percent Remaining	3
Percent Remaining Accuracy (%)	±30
Degree of Fragmentation	Human induced highly fragmented small stands with <50% extent remaining and high edge to area ratio
Recoverability	Poor health as structure and/or composition significantly altered. But sufficient biota remain for natural regeneration if causal factors and their secondary impacts removed and dynamic processes reinstated.
Threatening Processes	Clearing and ploughing for crops – wheat and cotton in particular. Salinity threatens parts of the Liverpool Plains. Weeds such as *Ammi majus, Lycium ferocissimum, Aster subulatus*, Lippia (*Phyla canescens*) and *Phalaris paradoxa* threaten some locations. Soil erosion is also a long term threat. Open cut coal mining is an increassing threat as coal mining increases in the Gunnedah Basin.
Threat Process List	Climate change; Dryland cropping; Irrigated cropping; Herbicides or fertilizers; Mining or quarrying; Salinity; Soil erosion; Unsustainable grazing and trampling by stock; Weed (exotic) invasion.
Variation and Natural Disturbance	Dominance of grass and forb species depends on grazing or ploughing history. Austrostipa aristiglumis will re-invade ploughed areas but other more sensitive species will not in the short term. Weed species include *Ammi majus* and *Aster subulatus*. Original grassland would have contained a higher abundance of palatable species such as *Themeda avenacea* and *Eulea auria*. Analysis of spring and summer sample plots indicates there is significant floristic variation due to the seasons.
Adjoining Communities	Grades upslope into Weeping Myall (ID27) or Western Rosewood – Wild Orange low woodland. Further upslope on basalt slopes grades into Yellow Box (ID437), White Box (ID433), or Poplar Box (ID101) grassy woodlands. A large proportion of the grassland species appears to occur as the ground cover in these woodland communities. A largely derived but similar grassland occurs on basalt hills on the Liverpool Range and around Merriwa in the upper Hunter where trees have been cleared (ID484).
Fire Regime	Unknown but now rarely burnt . Probably patch burnt by Aborigines prior to European settlement. Appropriate fire regimes may range from a minimum of 2 to over 10 years (Kenny *et al.* 2003). However due to fragmentation of habitat fire intervals need to take into account limited seed sources from unburnt patches and the possibility that weeds may proliferate.
Conservation Reserves	0
Total Area in Reserves (ha)	0
No. of Reps in Reserves	0
Explanation of Protected Areas	Not known from any protected area as of 2005.
Secure Property Agreements	0
Total Area in Secure PAs	0
No. of Reps in Secure PAs	0
Total Area Protected (ha)	0
Area Protected Accuracy (%)	0
Protected Pre-Euro. Extent (%)	0
Protected Current Extent (%)	0
Total Reps in Protected Area	0
Common (>10000 ha in 1750)	5a: <1% in protected areas
Common Qualifiers	Inadequately across distribution
Key Sites for Protection	Floristic survey of the grasslands in Allen & Benson (in prep.) highlights some sites of significance that should be protected. Most remnants occur on roadsides and stock reserves. One area of interest is Red Bobs Reserve just west of Lake Goran (Benson 1985). This contains a less disturbed patch of grassland. Grassland in good conditions occurs along the TSR south of Mullaley along the Mullaley-Tambar Springs Road.
Threat Category	Critically Endangered
Threat/Protected Area Code	CE/5a
Threat Criteria	4; 5; 1;
Planning and Management	Considering their threat status the Plains Grass Grasslands require protection under the Namoi Catchment Action Plan. The community is listed as Endangered under the TSC Act, therefore any clearing applications for remnants should be carefully considered and in most cases refused. Management should aim to avoid continuous grazing of the grasslands, however rotational grazing may be beneficial. Graziers need support to maintain their grasslands due to the high commodity prices available from producing crops. Weed control may be necessary in some key sites.
Listed Under Legislation	Listed TSC Act, E: Native Vegetation on Cracking Clay Soils of the Liverpool Plains (Part); Listed EPBC Act, CE: Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland (Part);
Recovery Plan (Yes)	None

Recovery Plan Required

Photo 1 ID102a_img241pc.jpg

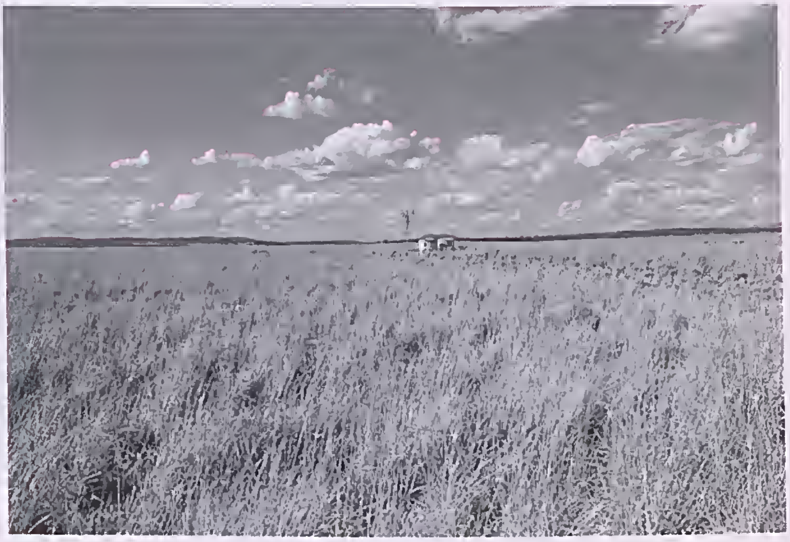

Photo Caption 1 ID102 *Austrostipa aristiglumis* grassland near Spring Ridge (AGD66) 31° 23'40.7"S 150°18'12.6"E. Photographer, Jaime Plaza, 18/10/01.

Photo 2 ID102b_img239pc.jpg

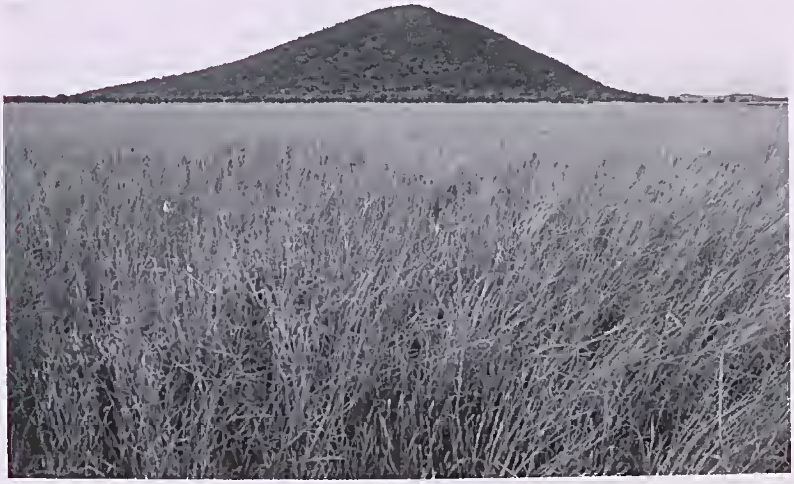

Photo Caption 2 ID102 *Austrostipa aristiglumis – Themeda avenacea* grassland near Mullaley (AGD66) 31 ° 08'46.2" S 149 °54'11.0" E. Photographer, Jaime Plaza, 18/10/01.

Photo 3 ID102c_BBSMar09_0751.jpg

Photo Caption 3 ID102 Liverpool Plains grassland on black earth soil dominated by *Austrostipa aristiglumis* and *Dichanthium sericeum*, near Bundella (AGD66) 31°28' 53"S 150°5' 12.1"E. Photographer, Jaime Plaza, 19/3/09.

Reference List 3; 202; 200; 308; 287; 209; 299; 199; 198; 201; 335; 459; 283; 473;

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Beadle, N.C.W. (1981) The vegetation of Australia. (Cambridge University Press: Cambridge); Benson, J.S. (1985) Investigation report – Red Bobs Reserve, Liverpool Plains File M1464. Report to NSW National Parks and Wildlife Service: Hurstville; Benson, J.S. (1994) The native grasslands of the Monaro region: Southern Tablelands of NSW. Cunninghamia 3(3): 609 – 650; Benson, J.S. (1999–2009) Unpublished field note books recording species at various locations in western NSW. (Royal Botanic Gardens and Domain Trust: Sydney); Duggin, J.A. & Allison, P.N. (1984) The grasslands of the Liverpool Plains, New South Wales. (Department of Environment and Planning: Sydney); Hosking, J. (2001) Flora of cracking clay soils of the Liverpool Plains. Unpublished flora list. (NSW Agriculture, Agricultural Research Centre: Tamworth); Kenny, B., Sutherland, E., Tasker, E. & Bradstock, R. (2003) Guidelines for ecologically sustainable fire management. NSW Biodiversity Strategy Report. (NSW National Parks and Wildlife Service: Hurstville); NSW Scientific Committee (2001a) Preliminary determination of native vegetation on cracking clays soils of the Liverpool Plains as an endangered ecological community. (Scientific Committee: Sydney); Sim, I. & Unwin, N. (1983) The natural grasslands of the Liverpool Plains New South Wales. (Department of Environment and Planning: Sydney); Soil Conservation Service of NSW (1970?) The vegetation of the Quirindi District. (Soil Conservation Service: Sydney); Resource and Conservation Assessment Council of NSW (RACAC) (2004) Joint vegetation mapping project, Brigalow Belt South Western Regional Assessment Stage 2 Resource and Conservation Division, Department of Infastructure, Planning and Natural Resources; Lang, R.D. (2008) Defining the original extent and florisitic composition of the naturally-treeless grassland of the Liverpool Plains, North Westerns Slopes, New South Wales. Cunninghamia 10(3): 407–421; Cannon, G., Cannon, M., Harding, W., McCosker, R., Spunner, B., Steenbeeke, G. & Watson G. (2002) Native vegetation map report No 3: Bellata, Gravesend, Horton and Boggbri 1:100 000 map sheets (NSW Department of Land and Water Conservation); Allen, C. & Benson. J.S. (in prep.) Floristic classification of the Liverpool Plains grasslands. Report to the Namoi CMA.

Appendix C. ID519: Short report (28 fields) of a highly restricted heathland occurring in granite landscapes in the west-New England Tableland region that is assessed as being Endangered.

Veg. Comm.ID No	519		
Common Name	**Heathy shrubland of the Howell area of the New England Tablelands Bioregion**		
Scientific Name	*Callitris endlicheri / Homoranthus prolixus – Babingtonia densifolia – Acacia triptera – Leucopogon neoanglicus / Lepidosperma laterale – Tripogon loliiformis – Paspalidium constrictum*		
Characteristic Trees	*Callitris endlicheri; Eucalyptus dealbata; Eucalyptus prava*		
Characteristic Shrubs/Vines/ Epiphytes	*Homoranthus prolixus; Babingtonia densifolia; Acacia triptera; Leucopogon neoanglicus; Prostanthera nivea* var. *nivea; Acacia granitica; Acacia neriifolia; Leucopogon muticus; Cassinia laevis*		
Characteristic Groundcover	*Lepidosperma laterale; Tripogon loliiformis; Cheilanthes sieberi* subsp. *sieberi; Paspalidium constrictum; Brachyscome stuartii; Fimbristylis dichotoma; Gonocarpus tetragynus; Aristida jerichoensis; Brachyscome stuartii; Bulbostylis pyriformis; Prasophyllum campestre; Trachymene incisa; Lobelia gracilis; Fimbristylis dichotoma; Commelina cyanea; Portulaca filifolia; Einadia hastata; Portulaca oleracea; Oxalis chnoodes*		
Structure	Heathland; Open Heath; Open Woodland; Shrubland; Sparse Grassland		
Vegetation Description	Low to tall heathland or open heath, low to tall shrubland, low open woodland or sometimes a sparse grassland. Occurs in hilly areas at intermediate elevations on or around outcropping coarse granites in the area between Copeton Dam and Goonoowigal. Also at Stannifer south-east of Inverell; with a minor occurrence to the south in and adjacent to Warrabah National Park. Trees are usually absent or very sparse, with the most frequent species being *Callitris endlicheri, Eucalyptus dealbata* and *E. prava.* Common shrub species are *Homoranthus prolixus, Babingtonia densifolia, Acacia triptera, Leucopogon neoanglicus, Prostanthera nivea* var. *nivea, Acacia granitica, Acacia neriifolia, Leucopogon muticus* and *Cassinia laevis.*The ground layer is often sparse with considerable bare rock, and frequently occurring species include *Lepidosperma laterale, Tripogon loliiformis, Cheilanthes sieberi* subsp. *sieberi, Paspalidium constrictum, Brachyscome stuartii, Fimbristylis dichotoma, Gonocarpus tetragynus, Aristida jerichoensis, Brachyscome stuartii, Bulbostylis pyriformis, Prasophyllum campestre, Trachymene incisa, Lobelia gracilis, Fimbristylis dichotoma, Commelina cyanea, Portulaca filifolia, Einadia hastata, Portulaca oleracea* and *Oxalis chnoodes.* This association represents the Howell Shrubland Endangered Ecological Community, which is poorly represented within the reserve system and is threatened in particular by feral herbivores. Howell shrublands may also occur within ID503 Black Cypress Pine – Orange Gum heath shrubland or woodland on granite outcrops of the New England Tablelands Bioregion and ID504 Black Cypress Pine – Rough-barked Apple – stringybark shrubby open forest of the Nandewar and western New England Tablelands Bioregions.		
IBRA Bioregion (v6)	New England Tablelands (>70%);		
CMAs	Border Rivers-Gwydir (>70%);		
Pre-European Extent (ha)	4000	***Pre-European Accuracy (%)***	50
Current Extent (ha)	3700	***Current Extent Accuracy (%)***	50
Percent Remaining (%)	92	***Percent Remaining Accuracy (%)***	±50
Conservation Reserves	Goonoowigal CCAZ3 67 (E3); Gwydir River CCAZ3 11 (E3); Warrabah NP 2 (E3);		
Total Area in Reserves (ha)	80		
Secure Property Agreements	0		
Total Area in Sec. PAs	0		
Total Area Protected (ha)	80	***Total Area Protected Accuracy (%)***	30
Threat Category	Endangered	***Threat Criteria***	2;
Threat/Protected Area Code	E/5b		
Photo	ID519a_NANNET.jpg		

Photo Caption	ID519 Heathy shrubland of the Howell area of the New England Tablelands, Munro State Forest near Copeton Dam (GDA94) 29°59’ 22”S 150°51’ 58”E. Photogrpaher, P. Richards, 25/10/2007.
Reference List	377; 380; 299; 172; 421; 407; 444.

Appendix D. ID113: Short report (28 fields) of Ooline forest, a western dry rainforest that is mostly cleared, naturally fragmented across its distribution and is assessed as being Endangered

Veg. Comm.ID No	113
Common Name	**Ooline closed forest on sandstone and conglomerate rises and hills in the Brigalow Belt South Bioregion**
Scientific Name	*Cadellia pentastylis – Casuarina cristata – Eucalyptus pilligaensis – Eucalyptus albens / Carissa ovata – Eremophila mitchellii – Psydrax odorata – Notelaea microcarpa* var. *microcarpa / Solanum parvifolium – Spartothamnella juncea – Cyperus gracilis – Einadia hastata*
Characteristic Trees	*Cadellia pentastylis; Casuarina cristata; Eucalyptus pilligaensis; Eucalyptus albens; Callitris glaucophylla; Eucalyptus populnea* subsp. *bimbil; Eucalyptus melanophloia; Eucalyptus viridis; Ventilago viminalis; Eucalyptus crebra; Alectryon subdentatus*
Characteristic Shrubs/Vines/ Epiphytes	*Carissa ovata; Notelaea microcarpa* var. *microcarpa; Eremophila mitchellii; Psydrax odorata; Capparis mitchellii; Acacia deanei* subsp. *deanei; Alstonia constricta; Elaeodendron australe* var. *angustifolia; Ehretia membranifolia; Dodonaea viscosa* subsp. *angustifolia; Dodonaea viscosa* subsp. *cuneata; Indigofera brevidens; Phyllanthus subcrenulatus; Breynia cernua; Beyeria viscosa; Pimelea neo-anglica; Maireana microphylla; Olearia elliptica* subsp. *elliptica; Geijera parviflora; Olearia canescens; Acacia buxifolia* subsp. *buxifolia; Exocarpos aphyllus; Santalum acuminatum; Pandorea pandorana subsp. pandorana; Jasminum lineare; Dodonaea sinuolata* subsp. *sinuolata; Abutilon oxycarpum; Pittosporum spinescens; Rhagodia parabolica*
Characteristic Groundcover	*Solanum parvifolium; Spartothamnella juncea; Cyperus gracilis; Einadia hastata; Einadia nutans* subsp. *nutans; Cheilanthes distans; Carex inversa; Poa sieberiana; Aristida gracilipes; Austrostipa ramosissima; Notodanthonia longifolia; Setaria paspalidioides; Sporobolus elongatus; Digitaria ramularis; Austrodanthonia racemosa* var. *obtusata; Chloris truncata; Aristida calycina* var. *calycina; Aristida ramosa; Stackhousia muricata; Rostellularia adscendens* subsp. *adscendens; Arthropodium milleflorum; Vittadinia sulcata; Vittadinia pterochaeta; Swainsona galegifolia; Veronica calycina; Abutilon oxycarpum; Austrostipa verticillata; Chenopodium melanocarpum; Phyllanthus virgatus; Nyssanthes diffusa; Einadia trigonos* subsp. *leiocarpa; Chamaesyce drummondii; Brunoniella australis; Boerhavia dominii; Leptochloa peacockii; Eragrostis megalosperma; Cymbopogon refractus*
Structure	Closed forest; Open Forest

Vegetation Description

Tall open forest dominated by Ooline (*Cadellia pentastylis*) with Belah (*Casuarina cristata*), White Cypress Pine (*Callitris glaucophylla*) and emergent eucalypts including White Box (*Eucalyptus albens*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Pilliga Box (*Eucalyptus pilligaensis*) and Poplar Box (*Eucalyptus populnea*). Often grading into Green Mallee (*Eucalyptus viridis*) mallee low woodland. A mid-dense, sparse or dense shrub layer may be present containing inland "rainforest" genera including species such as *Carissa ovata, Geijera parviflora, Alstonia constricta, Psydrax odorata, Capparis mitchellii* and *Notolaea microcarpa.* Other shrubs include *Eremophila mitchelli, Acacia deanei, Acacia buxifolia, Exocarpus aphyllus, Maireana microphylla, Olearia elliptica, Dodonaea viscosa* subsp. *angustifolia, Indigophora brevidens* and *Pimelea neo-anglica.* The vines *Pandorea pandorana* subsp. *pandorana* or *Jasminum lineare* are usually abundant. The ground cover includes the low shrubs *Spartothamnella juncea* and *Solanum parvifolium.* Grasses include *Aristida ramosa, Aristida calycina, Aristida gracilipes, Austrostipa verticillata, Sporobolus elongatus, Notodanthonia longifolia, Cymbopogon refractus* and *Poa sieberiana.* Forb species include *Einadia hastata, Einadia nutans* subsp. *nutans, Stackhousia muricata, Rostellularia adscendens* subsp. *adscendens, Arthropodium milleflorum, Vittadinia sulcata, Vittadinia pterochaeta, Swainsona galegifolia, Veronica calycina, Abutilon oxycarpum, Brunoniella australis* and *Boerhavia dominii.* Occurs on a slightly acidic, friable, clayey sand or light brown loamy sand to light clay soils derived from quartz of lithic sandstone, lateritic gravel and conglomerate substrates on various aspects and landform elements including hillcrests, footslopes and gentle hillsides at about 400 m elevation in the Brigalow Belt South Bioregion from Gunnedah in the south to near North Star in the north. The known southern limit is Black Jack Mountain near Gunnedah with a large area on Turkey Ridge 30 km south/east of Narrabri. Populations occur in Deriah CCAZ2 (AA) reserve and along Eulah Creek south east of Mt Kaputar, near Terry Hie Hie and around Gravesend in the north. A similar community on claystone occurs near the Queensland border (ID114) and extends into Queensland. This is a naturally restricted community with more than half cleared and most areas grazed. Listed as an endangered ecological community in NSW.

IBRA Bioregion (v6)	Brigalow Belt South (>70%);		
CMAs	Border Rivers-Gwydir (>70%); Namoi (1–30%);		
Pre-European Extent (ha)	2500	***Pre-European Accuracy (%)***	10
Current Extent (ha)	1000	***Current Extent Accuracy (%)***	10
Percent Remaining (%)	40	***Percent Remaining Accuracy (%)***	20
Conservation Reserves	Deriah CCAZ2 44 (M); Gamilaroi NR 56 (M);		
Total Area in Reserves (ha)	100		
Secure Property Agreements	0		
Total Area in Sec. PAs	0		
Total Area Protected (ha)	100	***Total Area Protected Accuracy (%)***	30
Threat Category	Endangered	***Threat Criteria***	2; 4;
Threat/Protected Area Code	E/5b		
Photo	ID113a_BBSNov07_1813.jpg		

Photo Caption

ID113 *Cadellia pentastylis* (Ooline) forest mature trees and suckers in Gamilaroi Nature Reserve near Terry Hie Hie (agd66) 29°50'49.62"S 150°9'50.82"E. Photographer, Jaime Plaza, 21/11/2007.

Reference List

211; 212; 283; 213; 210; 413; 450; 457; 463; 335.

Information for authors

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Version 3 of the NSWVCA database.
J.S. Benson, P.G. Richards, S. Waller & C.B. Allen

DVD to accompany New South Wales Vegetation classification and Assessment: Part 3 Plant communities of the NSW Brigalow Belt South, Nandewar and west New England Bioregions and update of NSW Western Plains and South-western Slopes plant communities, Version 3 of the NSWVCA database

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